CURRICULUM R & D:
INCUBATING CHANGE IN HIGHER EDUCATION

BY

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DISSERTATION

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Abstract

This mixed methods study examined incubation as a strategy for curricular change. The purpose was to examine the characteristics and effectiveness of curriculum incubation from a faculty perspective. The conceptual frame for this study proposed combining a grounded theory of incubation with concepts from organizational creativity to explain incubator processes. Findings concluded that while the incubator did engage is typical practices of nurturing, testing, and refining ideas, the salient characteristics of the incubator were most closely related to concepts of organizational creativity. The incubator examined in this study was in formative stages of development and data offered a thin slice of evidence supporting incubation as a mechanism of curricular change. Further study is warranted

This dissertation is dedicated to Dr. Laura Hahn

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Chapter I

Curriculum R & D:
Incubating Change in Higher Education

The curriculum incubator is an organizational change strategy in higher education. The incubator establishes a protected environment in which curricular experimentation conjoins with opportunities to adapt and implement change. Faculty use the incubator to test ideas on a small scale without regard to the current curricular plan. As ideas are tested, adapted, and outcomes documented, the academic environment is scanned to determine the potential for implementation. Only after a curricular change is deemed useful and viable are more permanent adjustments to the current curriculum considered. The intention of this cyclic research and development process is to minimize disruption to the status quo, but the effect is to gradually realign academic structure to the external environment and the needs of students, faculty, and other stakeholders.

The colloquial use of the term curriculum typically includes a broad range of educational purposes and processes. Alternately defined as a program or unit of measure (Hutcheson, 1997; Levine, 1978), a structure of learning (Berquist, Gould, & Greenberg, 1981; Toombs & Tierney, 1991), or the larger experience of students (Ratcliff, 1997), the curriculum sits at the apex of university life. Matters of curriculum define what it means to be educated; act as a conduit for the application of new knowledge; and leverage the collective conscience on matters of social and ethical reform. Curriculum is perceived so inclusively that almost any aspect of the academic experience of students might be included (Lattuca & Stark, 2009). Because the curriculum straddles the foundation of higher education, the strategic center of the institution, curriculum is

the logical place to begin change. If the curriculum changes, so does the institution. This dissertation explores the curriculum incubator as a mechanism to leverage organizational change.

Traditional approaches to curricular change typically begin with a planning process. At the heart of the planning process are lengthy discussions about an overarching model for the curriculum. However, the goals and purposes of higher education are so sweeping that curricular plans or models tend to reflect only the narrow range of "assumptions, values, and habits" of the planners (Lattuca & Stark, 2009, p. 19). The resultant plan is rarely able to adequately reflect the depth and breadth of purposes needed to satisfy the ever widening array of constituent demands. The curriculum planning process and resultant plan stimulate discussion over the merits of the proposal and a good deal of rhetoric ensues about the goals of higher education, but the conversation rarely clarifies issues or results in significant curricular change (Lattuca & Stark, 2009). The most important issues, such as what contributes to engaged learning, efficient and effective teaching, rarely become central to the conversation.

The curriculum incubator proposes to flip the traditional planned change process by beginning with consideration of curricular ideas that promote engaged teaching and learning, progressing to exploration and experimentation of alternatives, followed by discussions of merit and consideration for how new ideas might fit into a cohesive curricular plan. Issues of the exact fit to the academic plan and the details of course design remain fluid as all the pieces fall gradually into place. Because the curriculum incubator nurtures new ideas before subjecting them to conversations about merit, incubator processes may have the potential to overcome many of the hurdles faced by traditional curriculum development approaches.

Hurdles to curricular development tend to originate from the organization of higher education as embracing the simultaneous pursuit of widely divergent goals (Lincoln, 1986).

Goals of higher education are tempered by the knowledge and experience of faculty, the interests and needs of students, and the socioeconomic demands of society (Ratcliff, 1997). Institutional structure and the content of academic disciplines determine what should be included in the curriculum, how it should be structured, and delivered. This organization of higher education advantages free inquiry, diversity of understanding, and the pursuit of excellence, but disadvantages unification of goals, organizational change and adaptation (Zemsky, Wegner, & Massey, 2005). A curriculum incubator has the potential to leverage the advantages of higher education organization in ways that could unify curricular goals while fostering organizational change and curriculum development.

Statement of Purpose, Problem, and Research Questions

The purpose of this study is to examine the characteristics and effectiveness of a curriculum incubator in higher education from a faculty perspective. Data for this study was gathered over a period of 4.5 months during the second half of the first year of incubation processes. Findings provide a cross-sectional view of formative stages of curriculum incubator activities. The mixed methods design uses insights gained from qualitative data to assist in the development of a questionnaire administered at the end of data collection. Mixed methods are used to triangulate attitudes, beliefs, and activities of faculty affiliated with the curriculum incubator.

The curriculum incubator under study is called iFoundry. An acronym, iFoundry stands for Illinois Foundry for Innovation in Engineering Education. Situated in the College of Engineering at the University of Illinois, iFoundry is using a model reminiscent of business incubation programs to facilitate curriculum development. The goal of iFoundry is to foster cooperative interdepartmental relationships, new curricular approaches, and promote models of

undergraduate teaching and learning that better address student needs in the modern world (College of Engineering, 2007; Goldberg, & Cangellaris, 2008). New curricula are expected to maintain the highest possible standards for excellence while preparing the next generation to assume international leadership in technology, industry, business, and education.

IFoundry is analyzed in this dissertation as both an activity and a process focused on continuous and data-driven development of curricular alternatives. Two characteristics of iFoundry make it important to study. First, iFoundry is an example of incubator technologies applied to curriculum development. The merger of these two concepts as implemented by iFoundry advances the study of both curriculum development and incubation theory. Secondly, processes of incubation are employed as mechanisms for organizational change, which broadens perspectives on the purpose and process of incubation theory.

This study will analyze iFoundry by probing faculty understanding of curriculum incubator activities, observing incubator processes, and studying documents to determine the characteristics that define curriculum incubation in both theory and practice. Prevailing theories of incubation will be compared to iFoundry processes. Finally, a model or schema for iFoundry will link theory to practice providing a conceptual model and practical steps to establish continuous, data-driven curriculum development.

Research questions. In order to address the problem the following three questions are proposed:

- What are the attributes, characteristics, and key principles of the curriculum incubator?
- How do characteristics of the curriculum incubator align to theories of curricular change?

- What evidence is there that the design of the curriculum incubator is influencing curricular change?

Chapter one will continue by defining the background, foundational issues, and significance of the problem. A brief description of iFoundry is followed by the clarification of terms. A concluding summary will complete the chapter.

Significance of Study

Curricular change is a challenge for higher education. Although the academy relies heavily on discipline-based reflection, inquiry and research, the organizational structure and culture within the academy tend to inhibit exploration of curricular alternatives. Inhibitions to curricular change exist, in part, because of the view that students must master a critical mass of knowledge and information considered central to a discipline. This central core of knowledge is viewed as foundational, more fixed than evolving (Gumport, 2000). When issues of curriculum change do arise, additive responses tend to be favored over replacement (Gumport, 2000). One reason for favoring additive responses to curricular change is the difficulty of exploring the relative value or potential consequences of curricular options. Observations that curricular development is inhibited by these factors and others in the structure and culture of academia are not new (Lincoln, 1986; Masland, 1985), but fresh urgencies drive the need for institutions to adapt.

The external environment surrounding higher education has changed requiring parts of the system to rethink strategies and patterns that have operated effectively over a long period of time. Appearing from the outside to resist adaptation and seeming disengaged from those it serves, American higher education seems to be losing ground as the world's premier system of advanced learning (U.S. Department of Education, 2006; Kirsch, Braun, Yamamoto, and Sum,

2007). Critics frequently cite the curriculum as a case in point. Students have changed. Their preferences, goals, and aspirations seem unfamiliar. Student development efforts often appear out of step with real student needs. Weighed down by expanding requirements and threaded by prerequisites, the curriculum has become cumbersome and complicated for students to navigate. Advisors help students stay on track, but content often leaves students bored and confused about their major, their future. Besides being ineffective, the curricular structure is costly and inefficient, straining institutional resources and contributing to the high cost of education (Allen & Fitfield, 1999). Ironically, the source of these inefficiencies originates in the history and unparalleled success of America's higher education system.

Higher education in the United States has long been the world model for advanced learning. Unfortunately, that reputation is eroding (U. S Department of Education, 2006; Opstal, Evans, Bates, & Knuckler, 2007; Fischer, 2009). A changing socio-economic environment, including the mounting need to educate more citizens while simultaneously responding to the unique needs of an increasingly diverse student body, have challenged the model (Kirsch, Braun, Yamamoto, & Sum, 2007).[1] In addition what it means to be educated is changing.
Today, the depth and breadth of available knowledge is overwhelming (Lesk, 1997). Between one and two billion gigabytes of unique information are being produced each year (Lyman & Varian, 2000). In this environment exposing students to core content needed to succeed after graduation is a self-limiting exercise. In order to succeed in the world, students are also likely to need a variety of skills including those that favor the finding, filtering, and using knowledge.

[1] Throughout U. S. history, higher education has been viewed as a path to the American Dream. Over time this ideal

Although American higher education is justifiably proud of past accomplishments, current challenges suggest that this is not a good time to rest on laurels (U.S. Department of Education, 2006). Rapidly emerging new technologies may help address challenges if institutions can adapt hi-tech tools for educational use (Nelson, 1996). Still, the heart of the issue is whether higher education can become more adaptive to environmental challenges. Self-sustaining curriculum development is one way for institutions to respond.

The idea of self-sustaining curriculum development is not new. Halliburton (1977) argued that higher education should incorporate processes for continuous curricular change. More recently, the goal of creating mechanisms to stimulate curricular development has had many advocates, including former presidents of America's top universities (Bok, 2007; Duderstadt, 2008), policy making bodies with interests in higher education (Boyer Commission, 1998; U. S. Department of Education, 2006; Association of American Colleges, 1991); as well as scholars and researchers who study teaching and learning (Tight, 2004; Zemsky, Wegner, & Massey, 2005; Loui, 2007).

Unfortunately, serious and comprehensive reviews of curricular alternatives in higher education are rare and are rarely successful (Barnett & Coate, 2005). This may be due to the fact that few practical processes for curricular change in higher education have existed. Practical strategies are needed that can manage the relevance of higher education and facilitate self-sustaining curricular development. Any process for curriculum development should honor the culture and resources within the academy while simultaneously allowing experimentation, study, and implementation of new curricular strategies (Frank & Meyer, 2007; Trowler, 2008). In addition practical strategies that actually work must be able to adapt to the changing needs of different organizational contexts within the academy. The study proposed for this research, a

curriculum incubator called iFoundry, is examined as a systematic process for curriculum development. This dissertation explores the curriculum incubator as an organizational change process focused on the research and development of curricular alternatives.

Two subordinate and interrelated topics with the potential to add to the on-going dialogue among practitioners and scholars are also the focus of this study. First, strategies that facilitate balance between the steady reliability of the status quo and the accountability of curriculum development must become part of the academic culture (Druckman, Singer, & Van Cott, 1997). Second, it is important to consider alignment of real world environments to organizational structure, curricular focus, teaching and learning (Biggs, 2001). The goal is to establish an organizational structure and academic culture that acknowledges real world pressures while accommodating the subjective truths, recurrent practices, and discipline-based ideologies within the academy (Druckman, Singer, & Van Cott, 1997; Trowler, 2008).

Curricular change initiatives typically result in mediocre outcomes or simply fail (Cameron & Quinn, 2006; Kotter, 2007; Merton, Froyd, Clark, & Richardson, 2009). One reason is that both literature and practice treat all change as the same regardless of organizational context (Flamholtz & Randle, 2009). In addition, research has historically lagged practice in providing useful conceptual frameworks to guide initiatives (Trowler, 2008; Druckman, Singer, & Van Cott, 1997). Contextually specific or contextually adaptive theoretical frameworks are especially needed for higher education since the culture of the academy is unique from other organizational forms. Creating theoretical frameworks that practically link educational theory to practice could provide useful guidelines for considerations about integrating courses, curricula, and programs (Finney & Moos, 1992; Preskill & Torres, 1999). More opportunities to research and test frameworks that link theory to practice are needed (Baldwin, Hutchinson, & Magnuson,

2004). IFoundry, the subject of this analysis, provides a rare opportunity to systematically examine an emerging, theoretically-based, and comprehensive curricular change initiative in the formative stages of development.

Defining the Terms

This dissertation proposes to describe the curriculum incubator, identifying how incubator strategies act as an organizational change mechanism to influence curricular development and generate innovative approaches to curriculum. In order to examine incubator concepts it is important to define terminology. The discussion of terms that follows is meant to bring clarity to discussions often characterized by ambiguity and abstraction.

Curriculum. As it is commonly used, curriculum refers to a comprehensive academic plan, a series of courses within a college, department or academic discipline (Dressel, 1968, 1980; Gaff, Ratcliff, & Associates, 1996; Roy, Borin, Kustra, 2007). Defining curriculum as a plan reduces understanding to a set of courses that students must complete in order to graduate. The advantage of this definition is that it is clear and simple. The disadvantage is that this definition is difficult to operationalize.

Within an academic plan options may exist from which students select courses. Whether a student has many options or few is dependent upon the cultural and philosophical assumptions of the group that establishes the curriculum (Dressel, 1968). Is the curriculum student-centered, content-centered, or instructor-centered? Does the curriculum value historical foundations or anticipate problems of the future? Is the predominant orientation toward the abstract or concrete? Are students permitted to define their own educational goals and proceed accordingly or are students expected to conform to disciplinary norms by absorbing a specific body of core

knowledge? Curriculum that appear on the surface to be the same may be guided by very different assumptions about how a curriculum should operate or what it should accomplish.

It is true that in order to be certified for graduation a student must check off curricular requirements as prescribed by the institution, college and department. Beyond a checklist of courses to complete, may also be campus-wide requirements including minimum hours for graduation, general education alternatives, and occasionally other broad categories of aptitude such as knowledge of the U.S. Constitution, writing proficiency, cultural competency, and others. Together, these curricular requirements link matriculation to course offerings, credit hours, and degree completion (Lattuca & Stark, 2009). But beyond the surface operation of curriculum are less obvious but equally influential concerns.

When operationalizing the definition of curriculum linkages to the classroom become inescapable. Teaching practices, student learning, and content delivery become considerations (Lattuca & Stark, 2009). Practical necessity requires decisions on boundaries to content and sequences of learning. Appropriate instructional techniques and supporting resources must be identified and assessment practices established (Latucca & Stark, 2009). All of these elements are further linked to goals. It is in the details where curriculum gets bogged down.

Details of the curriculum organize the education of students. The associated premise is one of magnitude and quality. The curriculum should involve a significant and effective learning experience for students (Fink, 2003). The magnitude and quality of the curriculum influence structure, delivery of content, assessment processes. The curriculum is shaded by disciplinary assumptions and the anticipated needs of students. Depending upon cultural and philosophical assumptions, goals and objectives of a curriculum can be very different and result in very different educational experiences (Dressel & DeLisle, 1969).

The operational definition of curriculum is blurred by the fuzzy demarcation between what constitutes is a learning experience and what does not. One way of addressing this issue is to define curriculum broadly as the total learning experience of an undergraduate student (Ratcliff, 1997). This definition is broad enough to include a range of activities, courses, and programs that constitute undergraduate learning. Understanding the curriculum as the total learning experience validates divergent disciplinary contexts leaving room for interpretation of the details. This more comprehensive view defines the curriculum as a range of courses and integrated experiences influenced by sociocultural contexts both inside and outside the institution (Lattuca & Stark, 2009). Nothing in the learning environment is snubbed. Curriculum encompasses the depth and breadth of content and experience within the larger institutional environment (Dressel, 1968, 1980). This inclusive definition recognizes that academic growth occurs optimally in an environment rich with choices and that almost any choice supports learning (Association of American Colleges and Universities, 2002). The definition of curriculum adopted for this dissertation includes this broader definition: a range of activities, courses and programs that support student learning.

Curriculum development. By its very nature curriculum development implies change. Adjustments to the curriculum accommodate new knowledge and to respond to social and economic pressures. Typically, the curriculum changes often and in small chunks with each chunk organized around a series of faculty and administrative reviews. Learning processes, instructional resources, and assessment practices are organized around curricular goals and purposes (Dressel, 1968; Fink, 2003; Lattuca & Stark, 2009). The exact sequence of steps in curriculum development theory varies in the literature because steps are dependent upon attributes in the situation. More often than not, real world curriculum development is messy even

chaotic. The process varies because in the real world contextual factors in both the internal and external environment create push-pull effects that swirl about curriculum development efforts complicating carefully laid plans (Fink, 2003). That is what makes curricular development so complex.

Effective models for curricular change recognize the complexity of the process and acknowledge the necessity for identifying mechanisms to accommodate chaos and facilitate the process of change. If the model for change is well conceived and coordinated, the curriculum development process empowers faculty, students, and the institution (Ratcliff, 1997). On the other hand inadequate curriculum development processes are devastating because large numbers of students end up inadequately prepared for life after graduation. The shockwaves of inadequate curriculum development have the potential to reverberate endlessly through institutional reputation, student recruitment, success of graduates, alumni loyalty, donor generosity and so on. That is why institutions proceed carefully when it comes to organizing for curricular change. Using new methods or models for curriculum development are risky because poorly conceived change disrupts the smooth functioning of the institution and yields long-term unpredictable outcomes. The potential for curriculum development to become problematic incentivizes the status quo.

Much of the time maintaining the status quo means additive change (Dressel, 1968). Either a new course is added to the curriculum or a new series of courses or course options are added. Accomplishing additive curricular change is far less complex than replacing older curriculum with new. The simplest form of additive change involves adding or revising a single course. Individual courses are proposed by faculty and added to the curriculum with some frequency. Such changes undergo committee review at the department, college, institutional level

and state level. More complicated changes, like developing a new series of courses or new options for curricular choice begin by identifying a planning process, delineating responsibilities, and appointing a committee to propose and/or review changes before going through final review by committees (Lattuca & Stark, 2009). Both the process for individual courses and series of courses tend to be isolated events. They are time-limited bursts of activity in response to an expressed need for change.

As it is used in this dissertation, curriculum development is different. Curriculum development implies that efforts to refine the educational experience are self-sustaining activities within a disciplinary community which creates knowledge (Barnett & Coate , 2005). The bedrock of curriculum development is reliance on basic and applied research (Stenhouse, 1975). This interplay between research and practice recognizes both the evolution of knowledge and the practical nature of real world influences. Evolving ideas, principles, and philosophy form the foundation for improving the larger learning environment as well as the courses, activities, and programs within (Bruner, 1960).

The strength of the definition of curriculum development as a self-sustaining activity supported by research on practice can be observed in institutional strategies that link faculty development, organizational development, and curricular development (Gaff, Ratcliff, & Associates, 1997). By relying on collaborative research curriculum development leverages the strengths of many minds to inspire big ideas. As the term is used in this dissertation, curriculum development is a self-sustaining process of curricular refinement through research. The process of curriculum development is respectful of higher education culture and understanding of the nature of change in the academy.

Dissertation Overview

One primary assumption guides this research project: the traditional question about what undergraduates need to learn to be educated and productive members of society is the wrong question. The answer to questions about content or skills students need to learn will change with advancing knowledge leaving higher education always a step behind in preparing students for the world. A better question would ask what educational environment supports relevant learning in a real world characterized by change. Because curriculum incubation proposes an efficient system of self-sustaining curriculum refinement, curriculum incubation could be viewed as an adaptive organizational response.

This dissertation aims to use a survey of faculty together with interviews to describe the attributes, characteristics, and key principles of the iFoundry curriculum incubator. Since the curriculum incubator is an organizational change mechanism, incubator processes will be identified and aligned to theories of curricular change. Finally, faculty will be used to gage whether evidence exists that the curriculum incubator is influencing curricular change.

Since iFoundry is an initiative in the formative stages of development, evaluation of outcomes would be premature. Instead, the organizational processes will be identified and an attempt will be made to understand the possible future trajectory. That means documenting the program as it unfolds during early development. Efforts of this dissertation will be directed toward Patton's (2008) ideal: to determine both the formal details of the program as well as the informal patterns and understanding of faculty constituents.

Chapter II

Review of Literature

This dissertation studied one emerging model for curricular change called a curriculum incubator. Typically, incubators have been a business tool that attempts to overcome many of the barriers constraining transfer of new discoveries for commercial development. As a tool to support faculty research for the purpose of nurturing curricular change, incubators propose a limited risk laboratory in which to experiment, engage in trial and error, learn and adapt. The application of incubator strategies to curricular change produces a protective environment for organizational and curricular development with the potential to align well with the academic environment.

This literature review will consider theoretical foundations and research support for the focus of this project. Discussion will center on existing knowledge surrounding the purpose and scope of this project as well as understanding the basis for research questions and methods. An assumption of this project is that curricular change is an issue of organizational development. Therefore, considerations of change will be foremost in the literature review (See Figure 1). The literature review will be organized into five sections beginning with discussions of different theories of change. First incubator theory will be reviewed, then other theories with the capacity to inform incubation will be considered including: organizational creativity, evolution, and chaos theory. Discussions of engineering education and the special challenges of curricular development will ensue. Finally, specific information about iFoundry as a curriculum incubator will be considered.

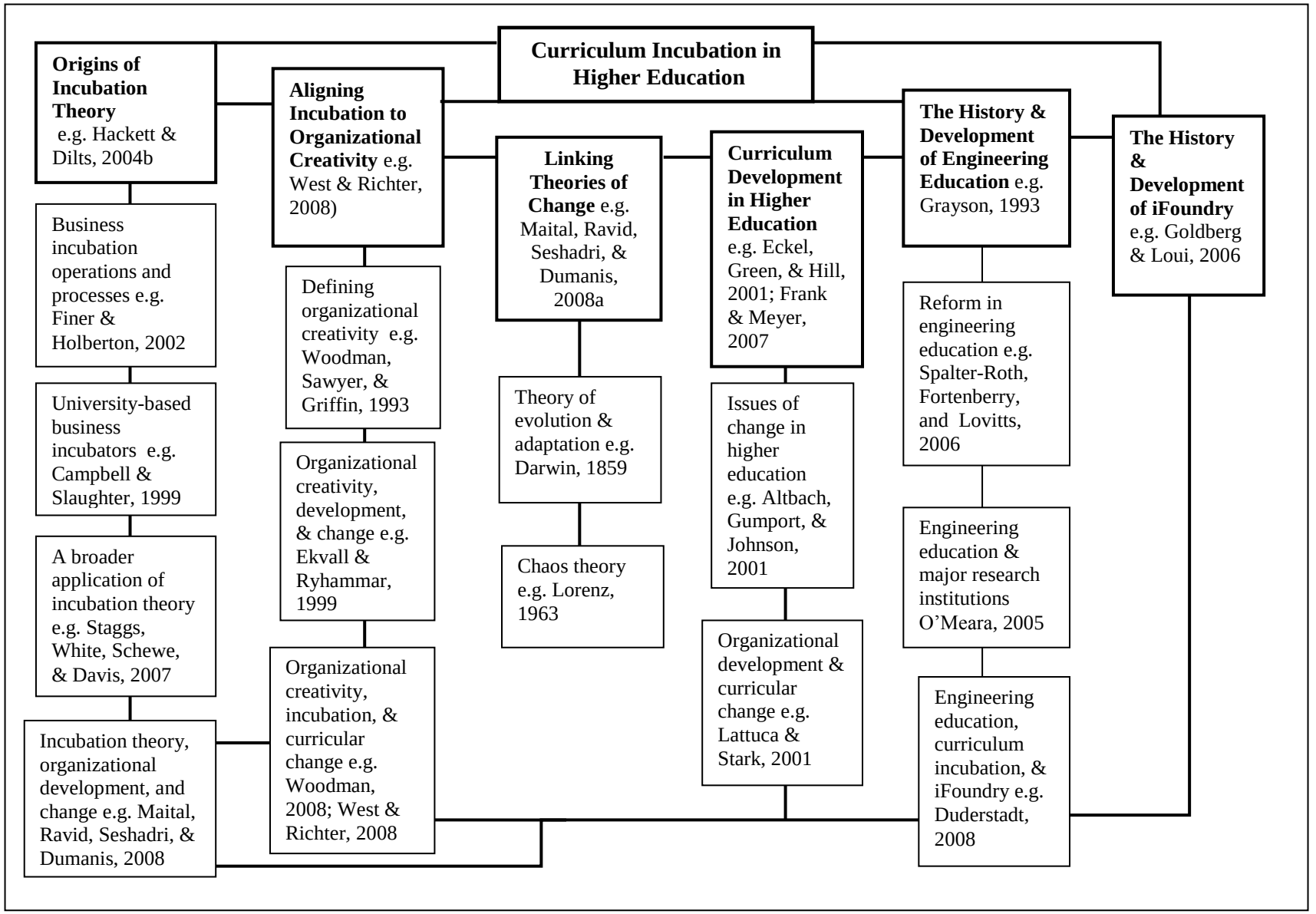

Figure 1. Content Map. Linear and relational structure of content organization through hierarchical classification

Origins of Incubation Theory

The concept of using sheltered environments to nurture risky new commercial ventures began in the late 1950's with the invention of community-centered business incubators (Atkins, 2002; National Business Incubator Association, n.d.). In the 50 years since the first business incubator, growing interest in the concept as a way to attract industry and promote corporate development has spawned the expansion of business incubators in community and university settings (National Business Incubator Association, n.d.). While scholarly interest in business incubators has resulted in the proliferation of empirical studies that examine their competitive and operational environment (Hacket & Dilts, 2004a), development of coherent theories to organize constructs and explain incubator processes has been limited (Hackett & Dilts, 2004b; Hannon, 2004).

The earliest research on business incubators began in 1984 with studies that focused on policy, description, and definition (Hackett & Dilts, 2004b). In the 1990's researchers began to examine the underlying concepts of incubator activities (Allen & McClusky, 1990). During the decade of the 1990's several conceptual frameworks for business incubation evolved, but no single framework emerged to define processes or provide conceptual clarity (Mian, 1997; Hannon, 2004). The bulk of subsequent research has built on these ideas, but remained deeply rooted in the practical aspects of venture capitalism.

Business incubation, operations, and processes. The foundational knowledge that exists on incubators focuses on using business incubation to overcome failure of production and sales for the marketplace (Hacket & Dilts, 2004a) and support economic development (Campbell, Kendrick, & Samuelson, 1985; Lewis, 2001). The most basic tools of business incubation involve offering sheltered support under conditions that minimize market pressures,

threats to viability ((Campbell, Kendrick, & Samuelson, 1985; Hackett & Dilts, 2004a), and accelerate time to market (Finer & Holberton, 2002). Financial exchange is the centerpiece of this design. Traditional business incubation is a form of venture capitalism where entrepreneurs receive opportunity to develop ideas in exchange for ownership rights (Finer & Holberton, 2002). Adequate funding allowing a successful launch of the fledgling company is provided (Maital, Ravis, & Seshadri, & Dumanis 2008a) in the expectation that profit levels will supply lucrative returns guaranteeing long term viability of the enterprise (Finer & Holberton, 2002).

University-based business incubators. On college campuses business incubators have served as a primary catalyst for entrepreneurial activities and economic development. Campus business incubators linked discovery and the marketplace providing a structure to facilitate the transfer of new research discoveries into profitable business ventures. Business incubators nurtured young companies by supplying business services, mentoring, and sharing office facilities. This process assisted the development of young business ventures while supporting the economic viability of the community through job creation and infusion of wealth (Bhabra-Remedios, & Lette, 2004). Universities embraced business incubation as the time-honored ideal of research for the sake of knowledge lost power. The financial benefits of commercializing products of faculty research lured institutions at a time when dwindling public funding needed to be supplemented through other means (Campbell & Slaughter, 1999; Slaughter & Leslie, 1997; Zusman, 2005). Universities have maintained that these market savvy relationships are a realistic response to a world dominated by technology and a highly competitive global environment (Ikenberry, 2001).

A broader application of incubation theory: The history of research and theory relating to incubation has been characterized by a focus on practical business development issues such as

those just described. Although knowledge of business incubators enlightens understanding of incubator strategies in other environments, such as the academic world, there are differences in these environments that alter the use and implications of incubators including their application to curriculum, teaching, learning, or the well-being of faculty and students in higher education.

The assertion proposed in this dissertation project is that, fundamentally, incubation is an organizational change strategy that supports development of nascent ideas by providing sheltered environments that nurture development until the ideas are viable and self-sustaining. This basic concept has very recently spawned limited applications of the incubation model for non-business or quasi-business use. One example of a non-business application of incubation theory is the curriculum incubator which is the subject of this dissertation. Using the business incubator model to shelter new educational ideas from inhibiting factors in the academic environment allows fledgling curricular designs to be fully explored, tested, and developed free from threats to viability.

Other emerging uses of incubator theory include applications in social change (Friedman, 2000; Kluver, 2004; Staggs, White, Schewe, Davis, 2007) and workforce development (Harrison, Cooper, & Mason, 2004; Katz, 2008). Incubation to nurture social change, for example, has largely been focused on providing a structure through which efforts at social entrepreneurship were protected from hostile and powerful outside interests. Incubation as a change mechanism for social entrepreneurship has met with limited success primarily due to the inability to financially sustain efforts (Friedman, 2000; Kluver, 2004). Using incubation theory as a tool to nurture workforce development has focused on developing talent. Within that model two approaches are found. One model uses incubation theory as part of a social change effort to assist disadvantaged and displaced workers in preparing for the workplace (Katz, 2008). The

other model focuses on the role of business incubators in developing entrepreneurial talent (Friedman, 2000). Efforts to use incubation to nurture social change or human development are challenging since funds to sustain the efforts are not generated by the incubation process. For these non-business or quasi-business applications, the concept of incubation is used to allow development of people or ideas without regard for direct commercial viability.

The process of applying incubation theory to non-business or quasi-business applications is complex because the value of the exchange is not measured monetarily. Market forces do not define these applications and success is not as readily quantifiable. Instead, success is indicated only after complex, almost chaotic, processes evolve over the longer term into self-sustaining programs. An additional complicating factor in curricular incubation is that the use of such models for curricular development is so new little research or theory is currently available. Because incubation appears to have potential to drive curricular experimentation and overcome inhibitions to curricular change, it is important to study this new tool as it emerges in higher education. Until recently, few attempts have been made to identify concepts and strategies for addressing issues of curricular change that are sensitive to variations in organizational dynamics and manifold visions for the larger learning experience of students. Strategies for organized study of curricular change are almost invariably complicated by factors in the organization of higher education that influence the direction and scope of curricular change.

Incubation theory, organizational development, and change. The topics of organizational development, sustainable change and their relationship to one another are not apparent in the literature surrounding incubation technology until 2008. Maital, Ravid, Seshadri, & Dumanis (2008a) first noted that business incubator strategies promoted a response to issues in the global business environment. Their perspective led Maital, Ravid, Seshadri, & Dumanis

(2008a) to consider change processes as moderated by cultural issues that are part of national character. Looking at incubation Maital, Ravid, Seshadri, & Dumanis (2008a) identified three principles of a new theory grounded in the idea that developmental paths of emerging businesses are moderated by factors in the organizational environment. These three principles conceptualize incubation broadly as developmental processes. Conceptualized as a developmental processes, the principles can also be generalized to non-business applications such as curriculum incubation: a) incubators which tend to facilitate successful transitions to self-sustaining enterprises shield ideas from forces that threaten viability while simultaneously mimicking the sense of urgency and external pressures that foster independence; b) the most effective incubators are opportunistic and able to successfully assist in the identification and navigation of environmental constraints; c) beneficial incubation processes recognize the central role of culture and help emerging ideas align to activities to the real world (Maital, Ravid, Seshadri, & Dumanis, 2008a). The work of Maital, Ravid, Seshadri, & Dumanis (2008a) represents the first effort known by this researcher to generalize principles of incubation formulating them into an integrated theory relevant across application and use (Maital, Ravid, Seshadri, & Dumanis, 2008b).

The work of Maital, Ravid, Seshadri, & Dumanis (2008a) is important because it contributed insights that broaden understanding of incubation theory to include the role of incubation as organizational development. The underlying process of incubator activity is to foster organizational development, and not just development but creative and innovative approaches to development, especially in environments that do not accommodate novelty (Maital, Ravid, Seshadri, & Dumanis, 2008a). What remains unknown is the identification of

dimensions in the environment that facilitate creative and innovative organizational development.

Although new to the concept of incubation, the idea of developing an environment which allows novel ideas to flourish is an underlying assumption of a significant body of literature called organizational creativity. Even though it is not directly linked to incubation theory, the literature on organizational creativity advances knowledge relating to the successful nurturing of ideas, the ability of organizations to innovate, and the capacity to overcome environmental constraints (Drazen & Schoonhoven, 1996).

Aligning Incubation to Organizational Creativity

The field of organizational creativity has as its base an emerging body of literature with the capacity to inform incubation theory. Concepts related to organizational creativity broaden understanding of incubator processes especially as they relate to organizational environments and change. Creativity involves a process of idea incubation in which reflection is used to ponder alternatives, identify potential strategies, consequences, and develop plans (West & Richter, 2008). Organizational creativity conceptualizes those processes within social and environmental parameters. The conceptual framework surrounding organizational creativity explains social and contextual influences that support processes involved in producing something new (Shalley & Zhou, 2008). Looking at incubation theory from the vantage of organizational creativity alters the application of incubation from a purely outcomes or market driven endeavor to one with the capacity to capture subtleties of the intervening dimensions of change.

A number of theorists have isolated factors in the structure and culture of organizations which support creativity and innovation. These factors operationalize theory into patterns and

processes that are predictive of organizational outcomes (Runco, 2007). Before looking at these patterns and processes, the theory of organizational creativity will be examined in greater detail.

Defining organizational creativity. Although creativity is traditionally viewed as an individualistic endeavor, a number of scholars have explored interpersonal and environmental factors influencing creativity as a change mechanism. Explorations of contextual factors surrounding creativity have produced a new understanding of how social and environmental factors can enhance creative change. Woodman, Sawyer, & Griffin (1993) first conceptualized organizational creativity by outcomes. These outcomes included value added by creative effort to products, ideas, services or processes developed through collaborative efforts of individuals in complex environments (Woodman, Sawyer, & Griffin, 1993). Ryhammar & Smith (1999) added theoretical detail by describing organizational creativity as investigation of critical components supporting creative efforts. Components included: organizational structure, culture, climate, resources, workload pressures, and leadership style (Ryhammar & Smith, 1999).

Over the last 10 years, scholars have broadened, clarified, and refined the scope of organizational creativity. By viewing the impact of contextual influences on creativity, scholars have linked research to overlapping constructs extending the theory of organizational creativity for purposes of investigation and practical application (Woodman, 2008). Today, organizational creativity is considered a subfield of organizational behavior (Shalley & Zhou, 2008). Organizational creativity is defined by interactive processes shown by research to either impede or encourage creative activity (West & Richter, 2008). Interactive processes are central components identified as predictive of creative outcomes (Runco, 2007; Williams & Yang, 2008). For example, West and Richter (2008) identify freedom from threat and pressure, diversity of knowledge, and valuing of ideas, and opportunity to explore alternatives as

stimulants for creative change. Other researchers have identified additional components which may promote and even predict organizational capacity for creative change.

Organizational creativity, development, and change. Several scholars have developed schema describing connections between values, beliefs and assumptions within organizations and the ability of organizations to change. These schemas tend to share a common core of assumptions that organizational characteristics promote creative approaches to change and problem solving. Playing off of the thinking and discovery of each other, these scholars frequently differ only in regard to categorical perspective and application of terminology. For example, Kay (1989) looked at components that produce an environment supportive of creativity. Central to Kay's (1989) theory was the premise that organizations needed employees to accept a common set of values to guide behavior. Amabile (1996) expanded on this idea identifying open communication as such a value. High conformity, on the other hand, acted to impede creativity (Amabile, 1988). Other contextual and environmental conditions also had the capacity to promote or minimize creativity. Amabile's (1990) model included eight dimensions: organizational encouragement, supervisory encouragement, organizational barriers, challenging work, supportive work group.

Ekvall & Ryhammar (1999) expanded thinking on organizational creativity by postulating six psychological conditions that described the behaviors, attitudes and feelings common to creative environments. An instrument developed by Ekvall & Ryhammar (1999) tested the following organizational dimensions: (a) Meaningful and challenging work accomplished by individuals to whom survival of the organization is important; (b) Employees have the freedom to engage in high levels of interpersonal interaction and take initiative unencumbered by rules; (c) Ideas and change initiatives are supported and encouraged in an

environment where listening is valued; (d) A trusting environment supports risk taking without fear of reprisal and ridicule if ideas fail; (e) Open debate occurs in an atmosphere characterized by equality, harmony, friendliness, and a disregard for prestige; (f) Opportunities exist for concrete experimentation and risk taking in an environment accepting of uncertainty (Ekvall & Ryhammar, 1999). Findings further revealed that bureaucratic order characterized by high levels of control were negatively correlated to creativity (Ekvall & Ryhammar, 1999). The work of Ekvall & Ryhammar (1999) is particularly relevant to this dissertation since the study was conducted at a university. Descriptive data revealed that the university which was the source of data for the study had an organizational configuration similar to other academic organizations tested by the same instrument (Ekvall & Ryhammar, 1999).

Research on dimensions of organizational creativity was developed by Ekvall beginning in the 1950's (Isaksen, Lauer, Ekvall, & Britz, 2001). Ekvall's research included examination of factors which appeared to moderate organizational processes including the abilities to solve problems, coordinate and accomplish goals, and innovate The factors Ekvall studied were rooted in individual perceptions that when aggregated become a shared psychology attributable to the organization and influential to organizational functioning (Isaksen, Lauer, Ekvall, & Britz, 2001). Ekvall (1991) identified 10 factors within the climate of an organization and developed a 50-item instrument to measure their presence. The instrument was called The Creative Climate Questionnaire (CCQ). The 10 dimensions of Ekvall's (1991) instrument were refined as the result of several large-scale organizational studies and factor analysis. The ten factors listed below are paraphrased and abbreviated definitions from Ekvall (1996):

> Challenge. A high challenge environment is one in which people experience emotional involvement, joy and meaningfulness in their work to the degree that time and energy are invested in accomplishing tasks.

Freedom. High levels of freedom allow people to act independently, take initiative and make decisions.

Idea Support. Environments with high levels of idea support are characterized by constructive and positive reception of new ideas. Suggestions are received positively. People listen to each other and find ways to try new things.

Trust/Openness. Organizations high in trust foster cooperation and sharing of ideas and opinions. There is no fear of reprisal in the face of failure.

Dynamism/Liveliness. High levels of dynamism foster stirring and eventful activities. There is steady alteration in ways of thinking and acting.

Playfulness/Humor. Spontaneity and ease characterize the organization when playfulness/humor is high. A non-stressful atmosphere pervades.

Debate. Many voices in the organization put forward ideas and many viewpoints are expressed. Diversity of knowledge and experience is considered beneficial to the organization.

Conflict. Tension runs high in an organization characterized by conflict. People dislike each other and political intrigue runs rampant. High levels of conflict are a negative factor for the institution.

Risk-taking. Experimentation is preferred to detailed analysis. Uncertainty is tolerated and the organization pounces on opportunity when it arises.

Idea Time. Organizations high in idea time provide opportunities to discuss and test fresh ideas. Discussions can be impulsive and do not have to be part of an assigned task.

Over the last 20 years, testing of the CCQ led to a refinement of the instrument. The factor of dynamism was removed conceptual and statistical arguments focused on 9 factors which performed with equal reliability and validity (Lauer, 1994).

Theorists, like Ekvall, who have studied environment as a way to manage creativity in organizations tend to look for normative behaviors that nourish creative solutions to pressing problems (Andriopoulos, 2001). The assumption is that behaviors are influenced by environmental factors such as shared values, beliefs, and assumptions. Using 3M as a case

study, Brand (1998) looked at how the shared regard for generosity, freedom, and safety produced conditions for innovation. Policies and procedures were intentionally put into place to reinforce these values. For example, life time employment coupled with global networks resulted in long term relationships characterized by diversity. People supported each other over time and distance without immediate expectation of reward, but understood that when help was needed, it would always be available. The environment characterized by Brand (1998) was "divergent and learning," "empowered and caring" with freedom to pursue topics of interest (Brand, 1998, p. 21). Brand (1998) found these factors could function as diagnostic tools which enabled creativity but needed to be reinforced by structure and systems.

Issues of situational influences on creativity are normally examined through measures of climate. In a 2007 meta-analysis of quantitative findings in organizational creativity research, Hunter, Bedell, and Mumford conclude that a taxonomy of 14 points adequately summarizes environmental dimensions supporting creativity. These include: (a) cooperation (Abbey & Dickson, 1983); (b) supportive supervision (Oldham & Cummings, 1996); (c) adequate resources (Amabile, Conti, Coon, Lazenby, & Herron, 1996); (d) challenging work (Oldham & Cummings, 1996); (e) clear organizational objectives (Thamhain, 2003); (f) freedom and autonomy (Ekvall, 1996); (g) low conflict/high harmony (Ayers, Dahlstrom, & Skinner, 1997); (h) open debate of ideas (Ekvall, 1996); (i) support for innovation (Anderson & West, 1988); (j) creativity is rewarded (Tesluk, Farr, & Klein, 1997); (k) flexible environment tolerant of uncertainty/ambiguity and supportive of risk taking (Ayers, Dahlstrom, & Skinner, 1997); (l) commitment to excellence (Sethi & Nicholson, 2001); (m) open, safe, participative environment (Anderson & West, 1988); (n) integration, cross-functional cooperation and alignment (Thamhain, 2003). As a result of their analysis Hunter, Bedell, and Mumford (2007) concluded

that organizational characteristics moderate and induce creativity and that those effects were not limited to the internal organization. The external environment produced powerful effects especially when innovation was necessary for organizational success (Hunter, Bedell, and Mumford, 2007).

Organizational creativity, incubation, and curricular change. In order to analyze the research questions for this dissertation project a conceptual framework is proposed that links curriculum incubation as defined by Maital, Ravid, Seshadri, & Dumanis (2008a; 2008b) to Ekvall's (1991) theory of organizational change. The purpose for merging the theories of incubation to organization creativity is to fill in dimensional detail and create a way to characterize and measure incubator change processes. Among the parallels between incubation theory and organizational creativity is their common root in the idea of change. It is difficult to imagine a creative organization without the tandem assumption of an organization that deals in change. The consequences of interactions among environmental characteristics in a creative organization invariably lead to change (Woodman, 2008). Together, the grounded theory of incubation (Maital, Ravid, Seshadri, & Dumanis, 2008a; 2008b) and Ekvall's (1991) theory of organizational creativity build a theoretical framework through which to describe the curriculum incubator.

Interestingly, literature on change avoids using the word creativity. For example, classic problem solving and decision theory refer to accidental or coincidental solutions based on non-rational processes (March & Olsen, 1976). This choice of descriptive language clearly implies that there are processes of change like creativity, problem solving, decision making, or some other phenomena that do not follow an orderly progression. In fact such processes often involve

concurrent complex chaotic activities that appear relatively independent of each other (Daft, 1978). These processes of change are not clearly understood and elaborated.

What is clear is the relevance of problem solving and decision making to creativity (Williams & Yang, 2009). It is true that not all change is creative, but all creativity does seem to involve change (Woodman, 2008). Outcomes that appear on the surface to be the result of non-rational processes seem to involve some form of creative synthesis, the progression of which is not clearly explained.

Cohen, March, and Olsen (1978) describe such non-rational processes as not being understood by organizational members largely because they are "inconsistent and ill-defined" (p. 1). Outcomes appear to evolve "capriciously" (p. 1) on the basis of trial and error. Membership in the decision making or problem solving process flows unsystematically (Cohen, March, and Olsen, 1978). Interestingly, Cohen, March, and Olsen (1978) indicate that most organizations experience limited periods of disorder, but specifically cite public educational institutions as most consistently defaulting to anarchical change.

Problem solving and decision making are not the only issues shared by change theory and organizational creativity. Although specific frameworks linking change theory to organizational creativity have yet to emerge (Woodman, 2008), theoretical basis for their overlap is apparent. Theory and literature on resistance to change, implementation, and intervention strategies share language and practices which inextricably link core ideas (Williams & Yang, 2009; Woodman, 2008). Generativity theory, for example, conceptualizes problem solving as change which transforms some established characteristics or processes into a novel and useful product (Epstein, 1990). It would seem equally valid to consider such change as simply creative.

The ability to develop novel strategies that overcome external challenges is a special kind of change; the kind of change that helps organizations endure in uncertain times (Woodman, 2008). Synergisms ignited by interactions between environmental characteristics and creativity actually empower organizations and facilitate change. Synergistic effects of these interactive processes induce foreseeable (Runco, 2007) innovative change (Woodman, Sawyer & Griffin, 1993).

The ability to change does seem to be empowered by the presence of a creative environment. Creative environments allow organizations to respond effectively when situations are changing and unpredictable. Creativity also fosters an atmosphere of well-being and productivity. Researching, describing and categorizing characteristics of a creative environment are useful because organizational characteristics that support creativity also foster resiliency (West & Richter, 2008). Theoretically linking organizational creativity, incubation, environment, and curricular change provides another way to understand and identify underlying concepts and assumptions as key characteristics or principles that predict creativity at the organizational level (West & Richter, 2008).

Linking Theories of Change.

Although this dissertation project used a conceptual frame merging incubaton theory to organizational creativity, it doesn't mean that other theories might in some way also align with the curriculum incubator. Although this dissertation assumes that incubation theory and organizational creativity align, it is possible that other change theories may also inform incubation, and specifically curriculum incubation. In order to explore alignment of theory to the concept of incubation more thoroughly, two other change theories will also be explored. Both the Theory of Evolution and Chaos Theory are significant theories of change. Examples of their

application to organizational change and possible alignment to incubation, specifically curriculum incubation are explored here.

The theory of evolution and adaptation. The Theory of Evolution is one of the most important theories in the history of human thought (Futuyma, 2005; Kilman & Johnson, 2005). Most closely associated with Charles Darwin's The Origin of the Species (Darwin, 1859) the central concepts explain biological change. The theory is complex and dangerous to oversimplify, but the following brief discussion attempts to distill the concepts most applicable to this dissertation.

Darwin's (1859) theory is that biological change occurs as the result of the chance activity of natural forces (Futuyma, 2005). Natural variation causes some organisms to have characteristics that are better suited for survival and reproduction than others (Futuyma, 2005). Survival or even domination by a species does not mean that the organisms are perfect for the environment just that they meet minimal criteria to survive. Survival is most probable when significant variability exists because variation prepares organisms to survive under many conditions. When organisms within a species vary widely and alterations in the environment occur, at least some of the organisms will have variations that are adaptive to the change and permit survival (Fisher, 1999). Naturally occurring genetic changes leading to variation tend over time to improve the average condition of a species (Fisher, 1999).

One measure of the strength of the theory of evolution is seen in how basic concepts have been extrapolated to address complex change processes outside of nature. Other scientific disciplines have attempted to emulate the change processes of evolution. The first attempts to mesh computer science with evolution began in the 1950's and attempted to propagate solutions to complex problems through the use of genetic algorithms (Holland, 1992). Other fields of

study including mathematics, psychology, artificial intelligence, economics, and engineering have also explored the theoretical foundations of evolution (Holland, 1992). Beyond its application to the scientific world, the theory of evolution provides a model capable of describing patterns in other very complex systems. Concepts within evolution such as natural selection and adaptation explain change in complex nonlinear systems.

Evolution has been applied to organizational change through the study of adaptive cultures. Organizations that are strong yet flexible are usually more successful at detecting environmental changes and redirecting their efforts to address problems appropriately (Ashkanasy, Wilderom, & Peterson, 2000). Adaptive organizations tend to be high performing and focused on continuous learning (Major, 2000). Failure is viewed as a valuable learning mechanism (Fulmer, 2000). The ability of organizations to successfully navigate change is dependent cultivating a culture that learns and evolves. Individuals within such organizations are expected to engage in on-going self assessments and goal identification (Hall & Mirvis, 1996). Variation is established by encouraging people at all levels of the organization to pursue their interests, set their own goals, and choose a path that will allow those goals to be met. Such organizations are complex and information rich; team work and information sharing are critical (Fulmer, 2000; Major, 2000). Expertise within the organization is combined and recombined in teams that address new problems as they arise. Change then becomes an opportunity for growth and development and a more successful future. Learning, growth, organizational, and personal development are idiosyncratic phenomena highly dependent upon nonhierarchical structures that engage in complex nonlinear processes. Adaptive organizations utilize change processes reminiscent of evolution.

Chaos theory. Chaos Theory looks at cause and effect relationships in nature to determine whether it is possible to make long-term predictions about the behavior of a system (Trump, 1998). The fundamental constructs associated with Chaos Theory are attributed to Jules Henri Poincare, a mathematician whose pioneering work contributed "key concepts and methods" (Aubin, 2009, p. 292). Chaos Theory was a response to Sir Isaac Newton whose theory of determinism became a foundation of science. Newton argued that his three laws (mathematical equations) could account for the observed motion of any imaginable process (Trump, 2003). Although over time his laws have been amended, Newton's idea of cause and effect remains foundational to many disciplines. The ability to perfectly predict relationships is dependent upon shrinking uncertainty by increasing preciseness of measurements (Trump, 2003). But, because perfection, absolute accuracy, is impossible some margin of error always exists. Chaos Theory states that any tiny margin of error can make a complex system unpredictable (Lorenz, 1963; Glick, 1987). In other words, what is not known can become more important than what is known (Taleb, 2010).

The term chaos as it is used in this theory does not imply anarchy, but it does mean that systems are much more complex and sensitive to small variations than prevailing analysis might indicate (Lorenz, 1963). Chaos theory considers responses that result from adaptive and self-organizing systems (Waldrop, 1992; Richardson, 2005). Even the smallest discrepancy in initial conditions will result in huge variations at different stages of a progression.

Chaos Theory is difficult to understand in greater detail without the use of mathematical formulas, because the nuances of effects are best described in nonlinear equations that reveal patterns in complex effects. However, by reviewing the philosophical underpinnings of chaos theory it is possible to understand why the central ideas have been adapted across many

disciplines including computer science, classical mechanics, economics, chemistry, psychology, life sciences, physics, education, organizational development and others. The possible alignment to curriculum incubation is a relevant discussion since the concepts have been widely applied to organizational change and specifically to the philosophy of change in education (Horn, 2008).

The difficulty of change in higher education is widely accepted. Change processes such as strategic planning, curricular reorganization, benchmarking, budgeting, assessment and other mechanisms have not led to significant educational reform (Reilly, 2000). One possible reason is that these change processes are linear, logical and presume rational responses to ideas with merit. Recently, chaos theory, which is nonlinear and presumes that patterns of change may on the surface seem erratic, has been used as both a descriptive and a prescriptive metaphor for change in higher education (Cutright, 1997). The value of using chaos theory as a lens to understand change processes derives from the conceptualization of organizations as complex social systems. Chaos theory frames organizations as self-organizing, self-sustaining systems capable of creating high levels of effectiveness and efficiency (Horn, 2008). The systematic thinking that dominates this orientation can be described by four principles (Thelen, 1989): (a) process is the focus; (b) parts of the system continually rebalance (c) task and circumstance determine behavior; (d) one or many variables can drive the system.

The theories of evolution and chaos contribute to understanding organizations as complex systems. Whether organizations live on the edge of chaos or evolve through adaptation, the idea of organizations as complex and sometimes unpredictable systems may align with concepts of incubation and specifically curricular incubation. Both theories are ways of looking at change, ways of initiating change, resolving change, or managing change. In this dissertation less consideration has been given to the theories of evolution and chaos than to consideration of

organizational creativity, but it is possible that research might have indicated alignment of any of these theories to processes of curriculum incubation.

Curriculum Development in Higher Education

Few would argue that undergraduate education needs to change. In fact American higher education has been engaged in a passionate debate about the nature and scope of change needed for over 20 years (Eckel, Green, & Hill, 2001). Practitioners and scholars agree that institutions need to adopt new approaches to undergraduate education because as the world changes what students need to know is also changing (Alexander, 2000; Getz & Siegfried, 1991; Gumport, 1988; Zusman, 2005). But, there are other issues as well. Of major concern in any curriculum development initiative are issues of cost and quality (Twigg, 2005; U.S. Department of Education, 2006). The task of changing undergraduate education is hard because resources of institutions are taxed by many divergent responsibilities. Colleges and universities need to distribute curricular resources thoughtfully and be accountable to stakeholders for delivering a high quality education. Incentives for change need to be built into the organizational structure that reward curriculum development aimed at improving learning outcomes through the use of cost efficient methods (Twigg, 2005)

Curriculum development requires time and money. Aimless dabbling in course or program modification is improvident when changes only partially address the core problem. Mechanisms must be found that allow for on-going testing of innovative curricular strategies. Processes must be incorporated into academic structures that address efficiency, effectiveness, and cost of undergraduate teaching and learning.

Although a natural place to begin exploring these issues is in the historical foundations and scholarly precedents that have shaped the modern institution, little in the evolution of

American higher education clarifies understanding. The debate over curriculum is as old as the institution itself, traditionally consisting of arguments over defining legitimate areas of academic study (Rudolph, 1962; Thelin, 2004). Throughout its history the culture of higher education has moderated curricular development through the unruly ebb and flow of stabilizing forces in academic culture and the lobbying influences of constituent interests in change (Bastedo, 2004).

This dynamic process captures what Gumport (1988) described as "the interactive and non-linear nature of knowledge production" (p. 52). Gumport's (1988) thoughtful analysis of curricula as influenced by social and cultural change calls attention to the amorphous fluidity of the scholarly process and the way it effects the institutionalization of knowledge. In higher education scholarly focus tends to define the structure and boundaries of knowledge which, in turn, influence curricula, the educational experience of undergraduates, and even the fulfillment of distant potential in individuals (Clark, 1987). The fact that faculty choose through the practice of research and teaching to define and construct what is commonly accepted as worthwhile knowledge is critically important to how institutions produce emerging generations of leaders and problem solvers. But the process can be reciprocal; what faculty choose to study often reflects real world concerns.

It has been almost 40 years since Hefferlin (1969) called for a better understanding of the "network of factors" (p. 52) that comprise the broader environmental context of the academic curriculum. Remarkably, although many scholars have addressed these issues through the years, wide ranging debate continues while institutions remain ensnared in the pursuit of just one question: What do undergraduates need to learn to be educated and productive members of society? (Bastedo, 2004). That question remains relevant because what students need to know continues to change.

The most recent impetus for curricular change has developed as dramatic shifts in the proliferation of knowledge and rapidly advancing technology pushed sweeping social and economic changes at the end of the 20th century. Ramifications of this new environment strike at the values and beliefs that undergird fundamental epistemological and pedagogical assumptions about learning. The problem is that change isn't built into the system of higher education and as such it just doesn't happen readily (Alexander, 2000; Boyer Commission, 1998; U. S. Department of Education, 2006). Institutions are struggling to find structures and processes that appropriately identify the knowledge and skills needed for students to be successful in the real world. In order to do that effectively, institutions must recognize that what students need to know will continue to change. Higher education must accept shifting realities and build an academic environment that effectively responds to change.

Institutions generally excel at delivering content to passive learners. However, integrating skill development with academic content remains a challenge. Higher education has consistently struggled to provide a curricular environment appropriate for mastering employment related skills (Kirsch, Braun, & Yamaoto, & Sum, 2007). That kind of learning has typically been left to stand alone experiences like internships, study abroad, co-curricular activities, practical opportunities, and other special programs such as campus career centers. It is not typically incorporated into academic content (Frank & Meyer, 2007).

Merging academics with skills development is challenging because such learning requires consistent and prolonged integration of content and practice. This kind of sophisticated learning environment requires a comprehensive framework of courses situated within a cultural context that accommodates the integration of knowledge acquisition with encounters that forgive failure (Argyris, 1991) and build understanding (Thompson, 2009). Such integrated methods to

learning are fundamentally different than typical curricular practices. Adopting an integrated approach to teaching and learning would change the college experience for undergraduates from the current knowledge-focused series of loosely dependent or independent learning. Instead, learning would be placed in the hands of the learner and would consist of academic study integrated with "managed experiences" (Frank & Meyer, 2007, p. 301). That is a big change and one that promises to be difficult.

Issues of change in higher education. The change process in higher education has been characterized as an ill-considered blend of persuasion, alliances and subterfuge (Kerr, 1963). At its best, change in higher education is a slow and haphazard process. In order for curricular change to happen in higher education, proposals must negotiate a series of hurdles conditioned by cultural dynamics to tilt implementation in ways that complicate and often disrupt the steady flow of progress (Trowler, 1998). The academy has been criticized for permitting these inhibitions that emerge from the historical traditions of the past, but has been equally disparaged for promoting unfocused curricular innovation and experimentation as the way of the future (Freeland, 2001).

Such contradiction characterizes higher education. In actuality, the truth is found equally on all sides of the arguments partly because institutions tend to "nod in all directions" (Freeland, 2001, p. 228) simultaneously. The problem is that in the modern world it is more important than ever for higher education to prepare students differently. Many institutions work hard toward productive curricular change. Still, it remains almost invisible to the outside world. It is invisible because curricular change is vulnerable to impediments, including prolonged discussion and review. So, even as curricular change occurs, the institution appears to stand still while the world outside changes rapidly.

Organizational development and curricular change. Multitudes of descriptors exist that attempt to capture the processes of change in the hope of providing guidance smoothing the path to curricular reform. Basically, organizational change can be viewed in terms of change that is planned and that which is unplanned. Much of the literature conceptualizes planned change as a thoughtful organized and linear process that involves developing an idea for change and convincing others to adopt or adapt the plan. Planned change in higher education has been the subject of much research and writing, resulting in a variety of models that illustrate the decision making process around change initiatives (Nordvall, 1982). The emphasis of these models is on a logical process which is characterized by open minded consideration of alternatives, evidence, and reasoned conclusions about options (Roy, Borin, & Kustra, 2007; Lattuca & Stark, 2009; Nordvall, 1982).

Within the larger category of planned change models are subcategories that capture the nuances of cause and deliberation. Curricular change may rest on the consequences of research or the diffusion of ideas from other sources. Curricular change sometimes becomes the basis for solving a problem, or results as part of larger organizational development initiative, or flows from a learning culture that strives for continuous improvement (Kezar, 2001; Lattuca & Stark, 2009). Each of these planning models offers a plethora of perspectives on curricular change prescribing an abstract and idealized process rather than offering a conduit for change (Conrad & Pratt, 1983). Unfortunately, most of these models resist broad applicability.

Successful curricular change initiatives often resist succinct translation to a model because real change is moderated by the organizational and contextual characteristics of the institution. Change initiatives that are successful may result from borrowing pieces of several models (Havelock, 1971; Lindquist, 1978). Reality doesn't necessarily follow a neatly planned

process. Great ideas may be abundant, but forethought, reflection, and inspiration are worth little unless they can be adapted and implemented in ways that make them strategically valuable to the organization (Scott, 2003). It is this translation from concept to implementation that makes curricular change complex. Capturing the complexity of change or the elegance of differing institutional conditions in a model is challenging. No consistent pattern emerges from the variety of curricular change initiatives to provide evidence for a detailed comprehensive and confluent model (Conrad & Pratt, 1983; Lattuca & Stark, 2009).

Any change initiative that uses rational and linear processes gets knocked about by social and political dynamics. Attending solely to the interplay of social and political dynamics involves using knowledge and ability to adapt in ways that may elude modeling. Organizations adapt in order to bridge constraints, align to environmental forces, react to internal and external policy, and respond to local interpretation. Unplanned or unpredictable change often appears to happen by accident (Kezar 2001). But, are unplanned or unpredictable changes really accidents? Complex change processes may appear unplanned when in reality they are just an organizational response, organizational adaptations to unseen circumstances (Senge, 1990; Weick, 1979). Figure 2 captures the complex dynamics of the curricular change process. The diagram is a modified version of Lattuca & Stark (2009, p. 302) schema of the sociocultural context of curricular change.

Throughout the 1980's and 1990's a series of change models attempted to embrace the complexities of curricular change by building on the ideas of adaptation, evolution, and feedback. Conrad & Pratt (1983) proposed a complex circular model meant to account for unanticipated behaviors by accommodating shifts in the order of decision making. Evolutionary models focused on situational variables and environmental influences that led to gradual

organizational change (Morgan, 1986). The idea of managing change as opposed to directing it was a requisite characteristic (Hrebiniak & Joyce, 1985). Systems Theory greatly influenced evolutionary and adaptive models by explaining how interrelated parts of an organization

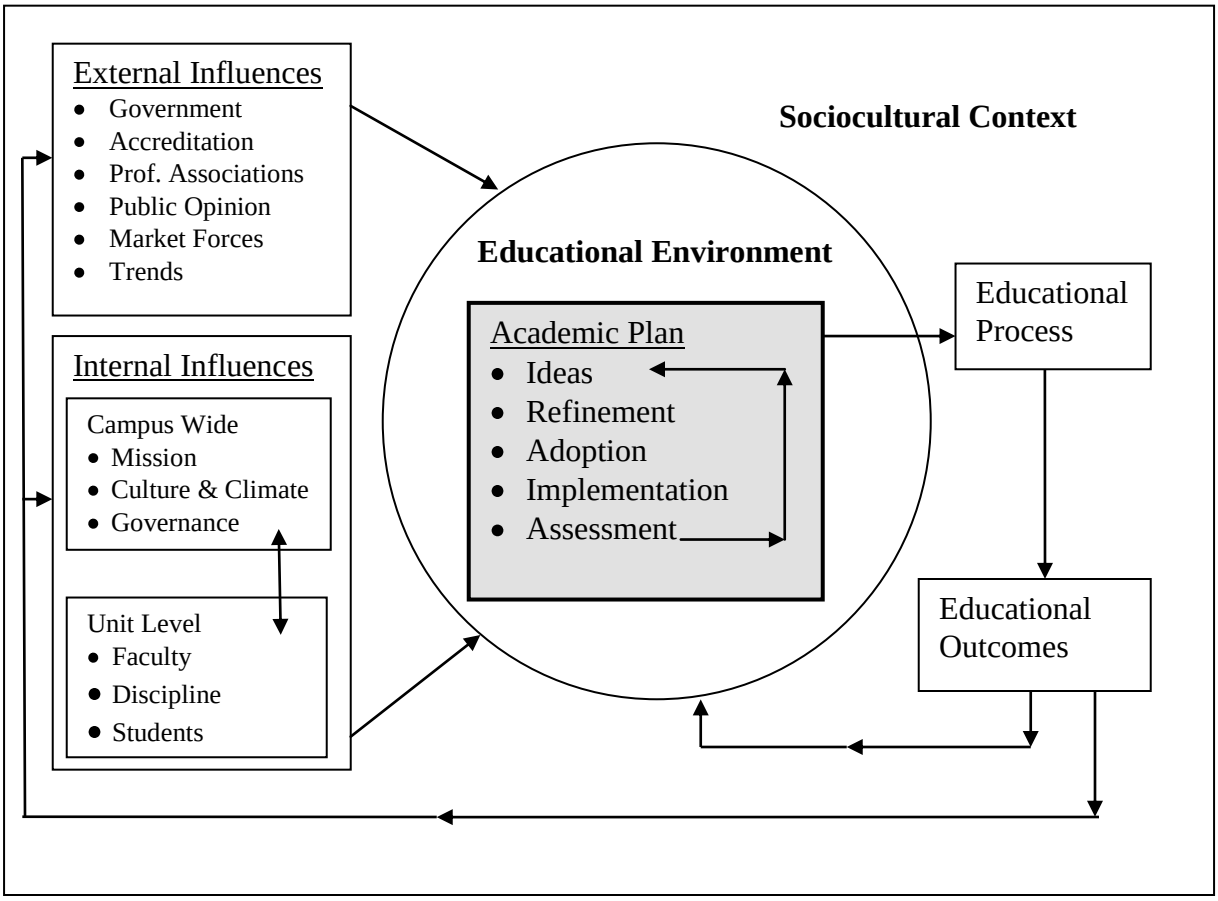

Figure 2. Overview of the traditional academic planning process. Adapted from: *Shaping the College Curriculum: Academic Plans in Context.* (p.302) by L.R. Lattuca & J. S. Stark , 2009, San Francisco: Jossey-Bass.

From the beginning evolutionary models relied on concepts of natural selection, diversification, and other Darwinian concepts to explain the likely interplay of environmental influences on the organization (Kezar, 2001). Other theories gleaned from science found credible voice in

organizational change models. Chaos Theory (Wheatley, 1999) drew attention to the organic properties of change including taking advantage of properties that are inherent to organizational systems and letting change emerge from that dynamic complexity. Although this approach to change grew to be very popular, the models were criticized for being overly deterministic and relegating human control, strategic choice, and creativity as inconsequential and irrelevant (Kezar, 2001).

The History and Development of Engineering Education

This dissertation is examining curriculum incubation as it evolves in a College of Engineering. The central purpose of the curriculum incubator is to modify the engineering curriculum. In order to understand the current engineering curriculum it is critical to first examine its history and development. A brief discussion of the philosophy, growth, and historical importance of the engineering curriculum follows.

Engineering educators have historically sought to balance resources against competing interests. The historical tug and pull of opposing forces in engineering education have caused institutions to periodically refocus and rebalance priorities as technology and the economy changed (Grayson, 1993). Most commonly, the interest in developing new knowledge through research has competed with the necessity to train new generations of engineers. The necessity to be thoroughly competent in scientific analysis vied with the desire to solve practical interdisciplinary problems (Harwood, 2006).

Representatives of these opposing camps have often seen the world quite differently (Harwood, 2006). Although scholars disagree about the specific origins of the rift, different curricular approaches may be due in part to the realities and myths surrounding engineering at the end of WWII (Goldberg, 1994) and Cold War tensions of the 1950's (Grayson, 1993;

Goldberg, 2009). Response to perceived threats resulting from the nuclear arms race and the rise of the Communist Party created the Cold War and fed America's intense competition to dominate the world through science and technology (Lukacs, 1961). The United States' highly successful drive to win the Cold War helped to foster a system of engineering education that emphasized depth of knowledge and technical, expertise learned through highly structured and strenuous course sequences in math and science (Goldberg, 2009; Grayson, 1993).

Throughout the later half of the 20th century, disciplined and sustained research efforts by American engineers with highly specialized technical training in science and mathematics facilitated advances that allowed the U.S. to lead the nuclear arms race, dominate in space, and spawned decades of national self confidence coupled with economic affluence (Grayson, 1993). During this period engineers became skilled technicians whose research refined knowledge deeply and within narrowly defined parameters. Intricacies of detail were perfected in highly specialized technologies. Highly structured engineering programs concentrated on the most rigorous engineering, math, and science training. As a result America became the international leader in technology over a relatively short period of time. Through the years as the depth and breadth of technological knowledge grew the game changed. By the beginning of the 21st century new approaches to engineering education were the topic of national conversation (Goldberg & Cangellaris, 2008.).

Reform in engineering education. Considerations of curricular reform in engineering education that began toward the end of the 20th century continue today as evidenced by the direction of national conversations such as the 2006 workshop on organizational change sponsored by the American Sociological Association together with the Center for the Advancement of Scholarship on Engineering Education (CASEE) of the National Academy of

Engineering. Funded by the National Science Foundation and broadly supported by engineering accreditation and governing bodies, the workshop was intended to culminate two decades of discussions relating to reform of engineering education. As has been typical of similar conversations the outcome of the workshop left participants feeling "hopeful, but not particularly confident" (Spalter-Roth, Fortenberry, and Lovitts, 2006, p. 28) in the potential for curricular reform of engineering education.

Conversations about reform of the engineering curriculum have resulted in some changes of content and delivery; however, the essential organization and structure of the curriculum remain the same (Grayson, 1993). An earnest concern for the engineering curriculum is the result of intense global competition and heightened employer demand for new skills especially those relating to creativity and innovation (Goldberg, 1994). Employers sought engineers with traditional math and science backgrounds who were also prepared to work in diverse environments developing new ideas and strategically applying them (Goldberg, 2006, Kember & Leung, 2005). Preparing engineers to assume more leadership responsibilities became a central part of that conversation. Engineering-led organizations leverage the sharp analytical skills characteristic of engineers. The most successful engineering–led organizations leverage transformative leadership and entrepreneurial thinking that position them to respond quickly to economic change and other challenges (House & Price, 2009).

Engineering education and major research institutions. Large institutions with nationally and internationally ranked reputations face very special challenges when it comes to curriculum. Reward systems, organizational structures, social status, and even public policy contrive to orient the collective psyche toward research and publication and away from teaching of undergraduates. The University of Illinois is a major research institution categorized by the

Carnegie Foundation for the Advancement of Teaching as a comprehensive doctorial granting public institution with very high research activity (The Carnegie Foundation, n.d.). Of the over 3500 higher education institutions in the United States only about 100 universities nationwide are considered research intensive (Boyer Commission, 1998). These research institutions are the primary source for generating new knowledge through the process of inquiry, experimentation, and exploration. In addition, these relatively few institutions train the majority of new scholars and professionals (Duderstadt & Womack, 2004). Undergraduate engineering education at research universities has been deeply influenced by the research environment. Reward and tenure systems are heavily skewed toward graduate education, competitive research, and publication agendas. The institutional structure and culture offers few incentives to faculty for good teaching even fewer rewards for efforts toward undergraduate teaching (O'Meara, 2005). The issue for major research institutions when considering curricular development is how to protect, funds, and maintain valuable research efforts while providing an efficient, effective, and economical engineering education for undergraduates that also meets standards of rigor and maintains or even enhances institutional reputation.

Engineering education, curriculum incubation and iFoundry. The need for curricular redefinition is widely acknowledged as necessary throughout engineering education (Duderstadt, 2008; Merton, Clark, Richardson, & Froyd, 2001). In addition interest in curricular change and renewal is wide spread in higher education generally and other institutions and departments may benefit from the example of iFoundry (Hilton, 2006; Kezar, 2001). One of the challenges of curricular development specifically and organizational development generally is that the collective experiences and mutually constructed assumptions of members tend to stabilize the organization (Schien, 2004). Stability performs many positive functions including reducing

uncertainty by establishing a social order, defining organizational identity, offering permanence, connection, community, and generating commitment to the organization (Trice & Beyer, 1993). In highly successful organizations, stability also protects the structure and processes that brought success and recognition to the organization. In order to succeed, organizational change efforts like curriculum development require, among other things, establishing a clear vision of a thriving future.

The curricular vision that iFoundry is proposing involves honoring the talents and aspirations of students. That means, among other things, providing students with alternatives and the means to control their own learning paths. Many students may prefer to be deeply trained within a specialty while others will choose career paths that require broader shallower knowledge. Such academic alternatives require successfully integrating a base of core knowledge while providing choices for supplemental content and skills development appropriate to the students' needs and personal goals. The unspoken caveat to this idealistic vision is a practical one. The educational process must be cost effective and scalable to large numbers of students. Unfortunately, few models and little evidence exist about how to offer this kind of individualization while maintaining the rigor and challenges that engage the best students (Kember & Leung, 2005). IFoundry, the curriculum incubator, is attempting to provide a framework for studying educational processes that address these and other issues.

History and Development of iFoundry

As a recognized activity in the College of Engineering, iFoundry is supporting curricular research and development in engineering education with the hope of making innovative contributions to the undergraduate engineering curriculum. Activities of iFoundry are managed from incubator offices which house two part-time faculty co-directors, a full time associate

director, and administrative assistant. Incubator faculty and staff provide a range of supporting services for curricular development efforts. Funding provided by the College of Engineering is supplemented by granting agencies and corporate friends.

The original idea, the genesis, for iFoundry grew originally from a 2006 initiative, Engineering and Technology Studies at Illinois (ETSI), a cross campus series of seminars, workshops, and interdisciplinary activities highlighting technology as a human interaction (Goldberg & Loui, 2006). As ETSI dialogues progressed, the concept of a curriculum incubator evolved to a life of its own. Spearheaded by a small group of creative faculty who had thought deeply about the engineering curriculum, iFoundry grew into a grassroots cooperative effort among five departments in the College of Engineering (Illinois Foundry for Innovation in Engineering Education n.d.).[2]

The bulk of early iFoundry activities involved dialogue and other consciousness raising activities among faculty. These activities concentrated on organizing and establishing the philosophy, strategies, and theories of curricular and organizational change. Interdisciplinary conversations among faculty intensified over the Summer 2007 resulting in the launch of the iFoundry website in the Fall 2007 (D. E. Goldberg, personal communication, January 11, 2010). In the Spring 2008, a review by the College Executive Committee resulted in a recommendation that the College support some kind of curriculum incubator initiative. In August 2008, Dean Ilesanmi Adesida formally announced the escalation of iFoundry to an official college-supported activity (Forrest, 2008).

[2] The original five departments were: Aerospace Engineering, Civil & Environmental Engineering, Electrical & Computer engineering, Industrial & enterprise Systems Engineering, and Materials Science & Engineering.

The organization of iFoundry had solidified by the Fall 2008 and discussions ensued over identifying ideas for curriculum incubation. A list of 34 courses and enrichment activities were subsequently identified for possible experimentation and evaluation (College of Engineering, 2007).[3] Faculty interested in experimenting with a new curricular design were awarded small grants in the Spring 2009. The grants were to be used to fund curricular changes for two years beginning in the Fall 2009 (D. E. Goldberg, personal communication, January 11, 2010). Faculty responsible for developing a course determined the experimental format of the course and the most appropriate assessment. As a result some variation in the nature of the curricular development and the assessment per piloted course resulted. The most heavily assessed pilot course and integrated activities were those identified as part of the Illinois Engineering Freshman Experience (IEFX, pronounced I-effects) (R. L. Price, personal communication, January 11, 2010).

A small group of 75 students were admitted to IEFX for the Fall 2009. The group of IEFX students and a comparative sample of students not participating in IEFX were surveyed, interviewed, and followed closely throughout Fall 2009. Of interest were both the student experience and learning outcomes. IEFX included: a course called ENG 198- Introduction to the Missing Basics of Engineering: Preparing for a World of Work & Service in a Creative Era. The course was supplemented with a series of co-curricular developmental activities based on team building, leadership, and student aspirations (iFoundry, 2009).[4] Subsequent evaluation reports indicated that the IEFX experience was transformative for participating freshmen (iFoundry, n.d.). The success of IEFX led to the recommendation that the course and integrated activities be

[3] A list of the original courses is available in Appendix A at the end of this document.
[4] Detailed descriptions of the IEFX components can be found in Appendix C at the end of this document.

scaled up to 300 students beginning in the Fall 2010. Practical issues like scalability and affordability were major concerns since curricular changes could ultimately impact all 1500 newly admitted freshmen (K. K. Hyman, personal communication, February 8, 2010).

Incubation of IEFX as well as other activities and courses, like IEFX, were supported by partnerships such as the one with Franklin W. Olin College of Engineering, a small private college which engages in innovative approaches to engineering education (OIP, 2008). In the Spring 2010, two courses were piloted through iFoundry using Olin course models and integrating Olin and UIUC faculty. Another partnership with Hewlett-Packard Development Company resulted in the recognition of the University of Illinois College of Engineering as was one of 10 colleges nationally to win the HP Innovations in Education Award (News, 2009, June 22). The award carried a cash and equipment prize to support course and program development. Relationship building has characterized iFoundry from its early inception. All kinds of partnerships, collaborations, conversations, and cross-disciplinary relationships have added to the continuing dialogue about engineering education at the campus level as well as nationally and internationally.

One of the distinctive features of the incubator has been the simultaneous, multidirectional, and over-lapping nature of developmental activities. Early organizing and establishing activities, such as consciousness raising and defining strategies, have been on-going and bled into other activities that would normally be considered "next steps." Figure 3 maps these activities in along a timeline. Four types of organizing and establishing activities are apparent: (a) Consciousness raising events, publications, and conversations among faculty and friends, and other stakeholders; (b) Exploration of concepts, philosophies, recommendations, and

information relating to the engineering curriculum, teaching and learning, and student development through widespread reading, discussions, and networking; (c) Knowledge development activities such as literature reviews including study of engineering, educational, philosophic, and psychological literature; (d) Consensus building through networking with faculty, students, and other stakeholders. Chapter 3 discusses iFoundry, the initiative that was the focus of this research, as well as the methods used to understand and describe the curriculum incubator.

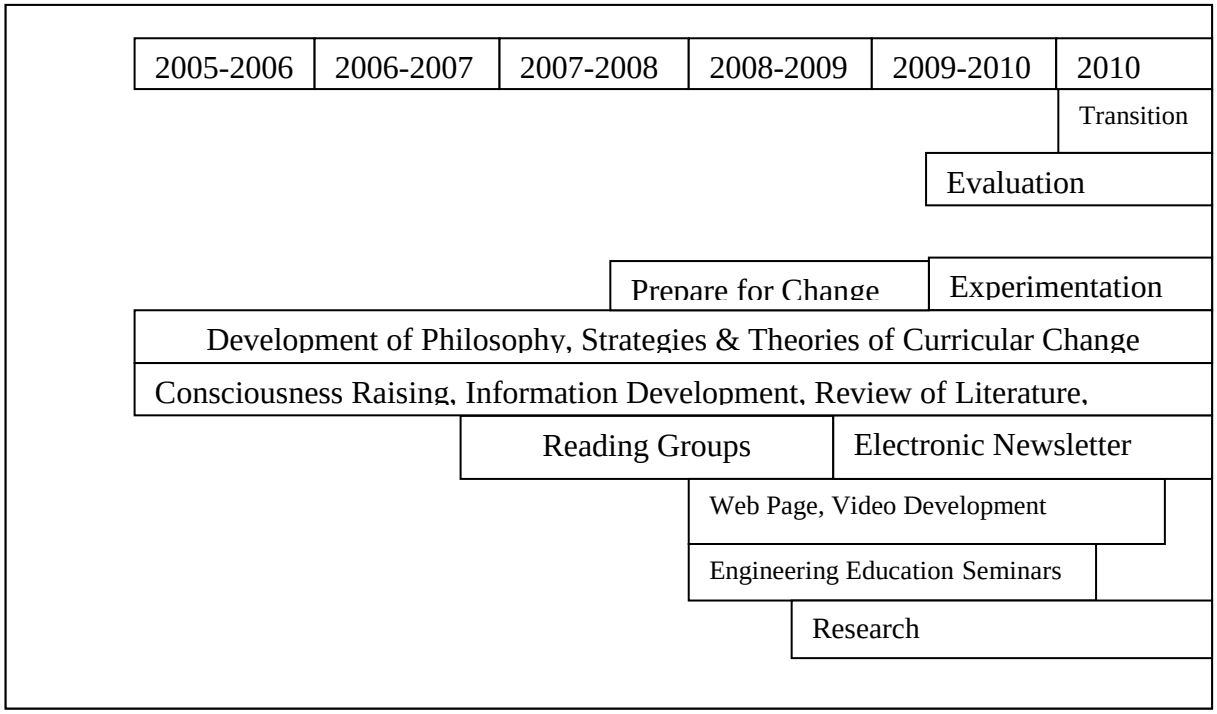

Figure 3. Formative curriculum incubator development. Map of over lapping activities was developed through cross analysis of documents, interviews, and observations during Spring 2010 semester.

Chapter III

Research Design and Methods

This analytical study used a mixed methods design (Tashakkori & Teddie, 2003) to examine characteristics and effectiveness of the curriculum incubator in order to determine incubator characteristics and attributes, underlying theories of the incubator, alignment to models for curricular change; and finally to determine evidence of incubator effectiveness. Using both quantitative and qualitative methods in a single study allowed a more complete understanding of the research problem (Creswell, 2002). Alone neither method was sufficient for capturing the perceptual nuances and complex understanding, but together, the methods allowed a holistic analysis (Green, Caracelli, and Graham, 1989; Tashakkori & Teddie, 1998). Chapter 3 begins by explaining the rationale for the design of this research, and proceeds to outline details of the setting, participants, researcher role, types of information collection, and methods. The chapter continues with a description of the research design, instruments, research tools, data collection and analysis procedures.

Context for the Study

Data gathering for this study began in January and ended in May 2010 which was the second semester of the first year of piloting curricular formats. This timing held one major advantage. Incubator processes were in full swing making the spectrum of activities available for observation. The first experiments in curriculum development had begun in the previous semester, Fall 2009, so issues were fresh in the minds of participating faculty. Evaluation of those first experiments was complete and outcomes were known. Plans to offer the first experimental curriculum on a larger scale during the next academic year were in development. At the same time two courses began the incubation process making it possible to observe the

curricular experimentation. The primary disadvantage of the timing for data collection was that incubator processes were still in formative development. Faculty had yet to gain any historical perspective or fully understand what results might be anticipated in the future.

In order to proceed knowledgeably, extensive use was made documents and observations which facilitated a broad understanding of the history, philosophy, and context of the curriculum incubator. In all, 25 documents, a series of blog posts, podcasts, Tweets, course syllabi, websites, and other related materials were reviewed. There were 18 observations of courses, meetings, co-curricular activities, and other events. Although document review and observations did not produce any data for the study, the methods performed two other functions. (a) Document review and observations supported deep understanding of the incubator by disentangling the sequence of historical events, exposing conceptual and contextual information and serving as a heuristic device (Creswell, 2009). (b) Documents review and observations of assisted in developing interview protocols and the survey instrument.

Interviews and a questionnaire generated data for the study. Interviews which occurred between January and April, permitted faculty to ponder the past, present, and possible future of the incubator and to offer their personal assessment on the importance of curriculum change. Questionnaires were distributed in May which also marked the end of the first year of active curriculum incubation. Questionnaires provided a systematic apparatus through which to standardize and measure responses to research questions. Coupling interviews with a questionnaire helped discover multiple perspectives (Schein, 1990) then find the convergence of data points (Greene, Caracelli, & Graham, 1989). Triangulation of perspectives was a key technique to orient findings, compare data, and ultimately strengthen reliability (Creswell, 2003, 2007; Yin, 2003).

Setting for the study. A curriculum incubator was the setting for this study. The curriculum incubator was an approach to addressing an expressed need for curricular change that responded to the social, political, and economic environment young engineers enter upon graduation (Goldberg, 1994). The central piece of incubator change efforts involved curricular experiments. During this study experiments were facilitated by multiple partnerships and relationships at many levels. Active partnerships and relationships were forged with students, administrators, and faculty on campus as well as at national and international organizations including other colleges and universities, corporations, professional organizations, accreditation bodies and interest groups. Although the perspectives of these contributors would have been important, this study was limited to faculty who participated in the incubator. Faculty participants were determined to be the primary catalysts for change and the key source for information about processes of change.

During the semester data was gathered for this study, thirty-eight faculty were members of iFoundry. These individuals represented 25 disciplines across campus. (See Table 3.1) Three categories of membership existed: iCouncil, iFellows, and Affiliates. ICouncil was an advisory board composed of 15 members from departments within the College of Engineering. Members of iCouncil acted as liaisons to their respective departments; meeting monthly to offer feedback, suggestions, and share information with iFoundry Co-Directors and staff. A second category of membership called iFellows consisted of faculty who engaged in curricular development activities, serving as course developers, instructors or advisors. A loosely organized interdisciplinary body, Fellows consisted of twenty-one faculty from across campus. Fellows met

Table 1

Distribution of iFoundry Faculty by Department

Department (N=22)	No. of Faculty Representatives (N= 39)
Aerospace Engineering	2
Agricultural & Biological Engineering	2
Art & Design	4
Business Administration/Entrepreneurship Center	1
Chemical & Biomolecular Engineering	2
Civil & Environmental Engineering	2
Communication & Coordinated Science Lab	1
Computer Science	2
Education	1
Electrical & Computer Engineering	4
Gender & Women's Studies	1
History	1
Human Factors – Institute of Aviation	1
Industrial & Systems Enterprise Engineering	5
International Programs & Studies	1
Labor & Employment Relations	1
Materials Science & Engineering	2
Mechanical Science & Engineering	2
National Center for Supercomputing Applications	1
Nuclear, Plasma, & Radiological Engineering	1
Philosophy	1
Physics	1

irregularly and meetings were largely social occasions. The third category of membership was Affiliates. Five faculty participated as Affiliates. IFoundry Affiliates were friends and partners within the College of Engineering who supported incubator activities, but did not actively

participate. As might be expected, membership categories overlapped with a few faculty participating on both iCouncil and Fellows.

Role of researcher. The subjective nature of qualitative research necessitated confronting the potential for unwitting personal bias (Denzin & Lincoln, 2000). The worthiness of qualitative findings, their catalytic validity, depended upon mitigating bias and establishing relationships that facilitate mutual constructions of meaning (Gergen and Gergen, 2000). Issues of subjectivity were addressed in two ways. First, it was crucial to introduce some objective standards that could stabilize the research process by introducing parameters for examining the research questions. The conceptual frame was selected as a mechanism to organize my thinking and to guide the inquiry in a focused and logical progression of ideas (Shields & Hassan, 2006; Dewey, 1938). Further discussion about the conceptual frame follows in the next section (see p. 60).

In addition, disciplined introspection and critical self-observation were among devices for confronting personal bias and establishing credibility in the qualitative portion of this study (Denzin & Lincoln, 2000; Patton, 2002). I felt fortunate that I was able to select a topic for this dissertation that was of deep personal interest. My previous professional experience in higher education first as an instructor then as an academic advisor had provided an opportunity to interact and observe students over the length of their undergraduate experience. As an instructor, I taught large groups of students in the classroom over the short stretch of one semester. Smaller courses enrolled 30 to 40 students and in the larger sections I taught up to 250. Although teaching was personally fulfilling, it seemed hopelessly disconnected from what the students were experiencing. To me, teaching felt like an arms length transaction and I could only hope that students were getting some value from my effort.

It was not until one of life's quirks brought me to the field of academic advising that I was able to relate to students through personal interaction over an extended period of time. As I talked one to one with students semester after semester, it became clear that many students also felt disconnected. Their lives happened outside the classroom and had little or nothing to do with their academic experience inside the classroom. Yet, there was plenty of spillover. What happened in the lives of students had the capacity to promote their academic engagement or derail it altogether. Observation and personal interaction of students with over time led me to believe that the disconnection of students from learning was a pivotal issue for higher education. Everyone in the learning community was doing their best. Students, faculty and administrators were all working hard, but there was just something about the system that inhibited the meaningful fulfillment of connectedness.

Because I had nagging questions about how higher education could better meet the needs of students, faculty, and administrators, I began to study psychology, counseling, and human development. That path eventually led me to the College of Education at the University of Illinois. In my program I continued to focus on individual learning paradigms but I layered that interest with the study of organizational influences on academic outcomes. I began to look at the ways curriculum could be evaluated and even how curriculum could be changed.

I liked the comfort and security of statistical analysis in research but felt that statistics supported fragmentation when learning needed to be understood in holistic terms. In this project I chose to take an idea apart statistically and then reunite it in qualitative analysis.

I confess knowing very little about the discipline of engineering or other academic areas of faculty interviewed in this study. My professional background is mixed. Having received an undergraduate degree in English from a small private liberal arts institution produced sympathy

for the value of a liberal education and a deep understanding of the lessons stories can teach. I earned a Master's in Business Administration which provided the basis for understanding the organizational structure, strategy, and how human behavior can change within an organizational context.

Several mechanisms were used to turn this background to an advantage. Reflexivity, critical self-observation, and personal accountability became important dimensions of qualitative analysis. Efforts to consciously step back, reflect and engage in self-examination tempered effects that personal history interjected (Clandinin & Connelly, 2000).

Choice of the curriculum incubator as the focus for this research was the result of a long-standing interest in the relationship between the academic environment and student learning. When it came time to chose a dissertation topic I actively sought an example of a curricular change effort to be the subject of study. Curricular change happens all the time in higher education, but I was seeking a particular type of curricular change, one that acknowledged and addressed organizational influences and their connection to student learning.

Access to the site was gained through a referral and subsequent meeting with a program co-director. Prior to this study, the researcher had no personal knowledge of the individuals associated with the curriculum incubator. This lack of history made it important to consciously develop levels of comfort, trust, and rapport with incubator participants. It must be noted that iFoundry faculty were accessible, interested in my dissertation project, and supportive of my research project. The willingness of faculty to cooperate and to share their opinions made it possible to understand program dimensions (Jones, Torres, & Armino, 2006) and organizational issues connected to iFoundry (Schein, 1990).

Conceptual Frame for Study

Instruments and protocols for this study were guided by a conceptual frame which was a constructed merger of broad ideas from incubation theory (Maital, Ravid, Seshadri, & Dumanis, 2008a; 2008b) overlaid by theory from organizational creativity (Ekvall, 1997) especially as organizational creativity contributes to change (Isaksen, Lauer, Ekvall, & Britz, 2001). Both incubation and organizational creativity are emerging disciplines of thought that have the potential to contribute to issues in organizational theory, especially about processes of change and curricular development. Together, these two concepts established an integrated and logical agenda for inquiry (Smyth, 2004). The purpose of the frame was fourfold (Goetz & LeCompte, 1984). First, the conceptual frame insured internal coherence for the study design becoming a guideline for organizing research questions, literature reviews, and methods. Second, the conceptual frame united the mixed method non-experimental procedures establishing a rationale for exploring the nuances of iFoundry characteristics and effects. The conceptual frame supplied integrating logic for methods including qualifying findings, stimulating insights and justifying perspectives of the research methods. Third, the frame guided discovery and analysis. In doing so, concepts of the frame supported the credibility and trustworthiness of the research. Lastly, the conceptual frame bounded discussion by establishing a logical reference for linking literature, methods, and data analysis and findings.

A grounded theory of incubation formed one part of the conceptual frame. Three principles organized incubation concepts as strategies for organizational development (Maital, Ravid, Seshadri, & Dumanis, 2008). These principles were: (a) shielding ideas from forces that threaten viability while simultaneously mimicking the sense of urgency and external pressures that foster independence; (b) assisting in the identification and navigation of environmental

constraints; (c) recognizing the central role that culture plays in influencing perceptions and behavior. These principles situate incubation as a strategy for organizational development that recognizes socially constructed environmental constraints.

Embedded in the principles outlined by Maital, Ravid, Seshadri, & Dumanis (2008) are "mediating variables" (p. 1) identified as values, beliefs, and attitudes in the environment that influence change by affecting the perception of alternatives, speed and configuration of behaviors and ultimately the ability to succeed, innovate, and implement. These variables have mediating consequences which masquerade as reality, coloring the interpretation of events and subsequent adaptive responses. In order to better understand details about these values, beliefs, and behaviors, it is important to identify them in greater detail. That is where concepts of organizational creativity can be helpful. Concepts of organizational creativity add dimensionality to principles of incubation by identifying and defining the "mediating variables" (p.1) cited by Maital, Ravid, Seshadri, & Dumanis (2008) as values, beliefs, and behaviors.

Ekvall's (1991, 1996) theory of organizational creativity identifies those variables. Ekvall (1996) defined 9 dimensions of climate which added descriptive detail about "mediating influences" cited by Maital, Ravid, Seshadri, & Dumanis (2008, p. 1). Ekvall's (1991, 1996) dimensions form a taxonomy for representing perceptions, feelings, and behaviors that exist as independent organizational attributes (Ekvall, 1987). These dimensions originate in the substratum of organizational life forming an objective reality that moderates organizational processes and subtly influences consequences. The confluence of these dimensions is determinant of organizational responses and outcomes (Ekvall & Ryhammer, 1999). The level and configuration of dimensions impact organizational processes situating the organization for productive change or constraining responses to challenges (Isaksen, Lauer, Ekvall, & Britz,

2001). Ekvall's (1996) mediating variables include: challenge/involvement, freedom, trust/openness, idea time, playfulness/humor, conflict, ideas support, debate, risk-taking. (See Table 2) The nine dimensions of Ekvall's theory have been operationalized and refined into scales that measure their presence (Ekvall, 1983, 1986, 1991, 1996, 1997; Isaksen, 2007a, 2007b; Isaksen & Ekvall, 2006; Isaksen & Lauer, 1999, 2001; Isaksen, Lauer, Ekvall, & Britz, 2001). Concepts of organizational creativity were used in this dissertation to test the applicability of organizational creativity as the dominant factor of incubator functioning.

Rsearch Design

Because both qualitative and quantitative methods occupy roles in this research project, consideration needs to be paid to the distinct paradigms that characterize each form of empiricism. The rationale for a mixed methods design (Tashakkori & Teddie, 2003) was that merging data provoked a fuller and more complete understanding of the problem (Creswell, 2002). Qualitative inquiry has a nontraditional inductive epistemological foundation, systematic procedures, and philosophic exactitude which form a distinct orientation to truth and analytical veracity. Arguments for the fidelity of qualitative methods are grounded in thoughtful design, sampling strategies, data collection, and analysis (Denzin & Lincoln, 2008).

Quantitative paradigms relied on deductive logic grounded in postpositivist statistical traditions. Although statistical processes are formulaic and therefore limited to the bounded purity of mathematical logic, reductionist thinking in this study promoted clarity by distilling of concepts down to measurable elements capable of addressing the research questions fully. Used together, qualitative and quantitative research methods complemented each other allowing

Table 2

Operationalizing Organizational Creativity as a Concept of Incubation and Change

Ekvall"s (1996) Dimensions of Organizational Creativity	Operational Descriptions (Isaksen, 2007)
Challenge/Involvement	Members are intrinsically motivated and committed to making contributions to the success of the organization. Members find joy and meaningfulness in their association with the organization.
Freedom	Members exercise discretion and independence in their role with the organization. Members feel free to acquire and share information, make plans and decisions regarding their work.
Trust/Openness	High levels of trust exist among organizational members. Individuals feel comfortable being open and frank with each other. Organizational members have sincere respect for one another, count on each other, and offer personal support.
Idea Time	Opportunities exist for exploring and developing new ideas. An atmosphere of flexibility permits testing of new ideas.
Playfulness/ Humor	An atmosphere of spontaneity and ease exits in the organization. The organization fosters an easy going, good natured, and light-hearted approach to tasks.
Conflict	Levels of tension and hostility are low or nonexistent. Organizational members behave with emotional maturity, control impulses, and have psychological insights.
Idea Support	New ideas receive constructive and positive attention. Opportunities exist to try out new ideas. New ideas are <u>not</u> received with fault finding and obstacle raising. The default response of "no" does not dominate.
Debate	Members discuss opposing opinions and share a diversity of perspectives. Many opportunities exist for sharing differing experiences and knowledge.
Risk-taking	Tolerance of uncertainty and ambiguity exist in the organization. Members gamble on new ideas. Bold initiatives are possible even when the outcomes are unknown.

a more complete analysis and richer deeper findings (Green, Caracelli,& Graham, 1989, Tashakkori & Teddlie, 1998).

IRB approval was received for the research design and all protocols prior to initiating data collection. Documentation was submitted for IRB approval in early December and approval was received December 10, 2009. One amendment was filed on March 29, 2010 when the survey was revised. Approval for the revised questionnaire was received April 1, 2010. The topic was not considered sensitive and the population included only adults. Procedures appropriate to methods were adopted for obtaining informed consent and confidentiality was protected both by procedure and by masking identities on interviews and questionnaires.

Qualitative design. Interviews supported an emergent design grounded in interpretation of meaning, perceptions, and contexts (Patton, 1990). The prevailing paradigms were phenomenological and constructivist. It was through interviews that major themes emerged which formed the foundation and became the focus for questionnaire design. Throughout this study the researcher adopted a sense of appreciative inquiry (Cooperrider, 1990; Hammond, 1996; Hammond & Royal, 1998; Kinni, 2003). No claims for generalization of qualitative findings were be made although, in some instances, evidence was strong enough to argue for broad applicability (Yin, 1994). In this regard, Yin (2003) contends there is little difference between a single qualitative study or a scientific experiment, since findings from both need to be replicable in order to generalize with confidence.

Qualitative research participants. A purposeful sample (Patton, 1990) of eighteen faculty were nominated for interviews by an iFoundry Co-director. The nomination procedure involved sitting down with an iFoundry Co-Director and discussing the organizational structure and variety of faculty participation. It was clear from listening to the Co-Director that faculty

perspectives would vary widely depending upon the focus of their participation and level of activity with iFoundry. Generally participation fell into hierarchy of three broad categories that reflected the depth and breadth of participation: (a) a central core of faculty were involved with IFoundry incubator development and daily operations; (b) another group of faculty actively taught and administered courses and related activities that were being incubated; (c) a third group of faculty provided moral support and expert guidance but were not routinely involved with iFoundry activities. This three tier model became the sampling frame for selecting potential candidates for interviews. Six candidates in each of the three tiers were nominated as potential candidates to be interviewed. This sampling strategy allowed maximal variation in the sample. (Figure 4).

Included in the pool of 18 were College of Engineering Deans, Faculty, iFoundry staff, and individuals engaged in a broad array of curriculum research and development activities. The purposeful sample represented 44% of the 41 members in the pool, and 10 (45%) of the 22 departments represented in iFoundry. Six faculty from each tier were recruited fro interviews. Tier 1 consisted of iFoundry founders, iFoundry Co-directors, staff, researchers, and others whose affiliation with iFoundry was central to the development and operations of the incubator. Tier 2 included faculty and administrators involved with teaching/developing undergraduate curriculum and related programming. The activities of these faculty were central to iFoundry functioning. Tier 3 included Fellows. Faculty designated as Fellows were actively interested in issues relating to the undergraduate curriculum, but the manner of their participation varied. The support of this group for iFoundry activities was essential to incubator success, but this group generally did not engage in regular incubator activities.

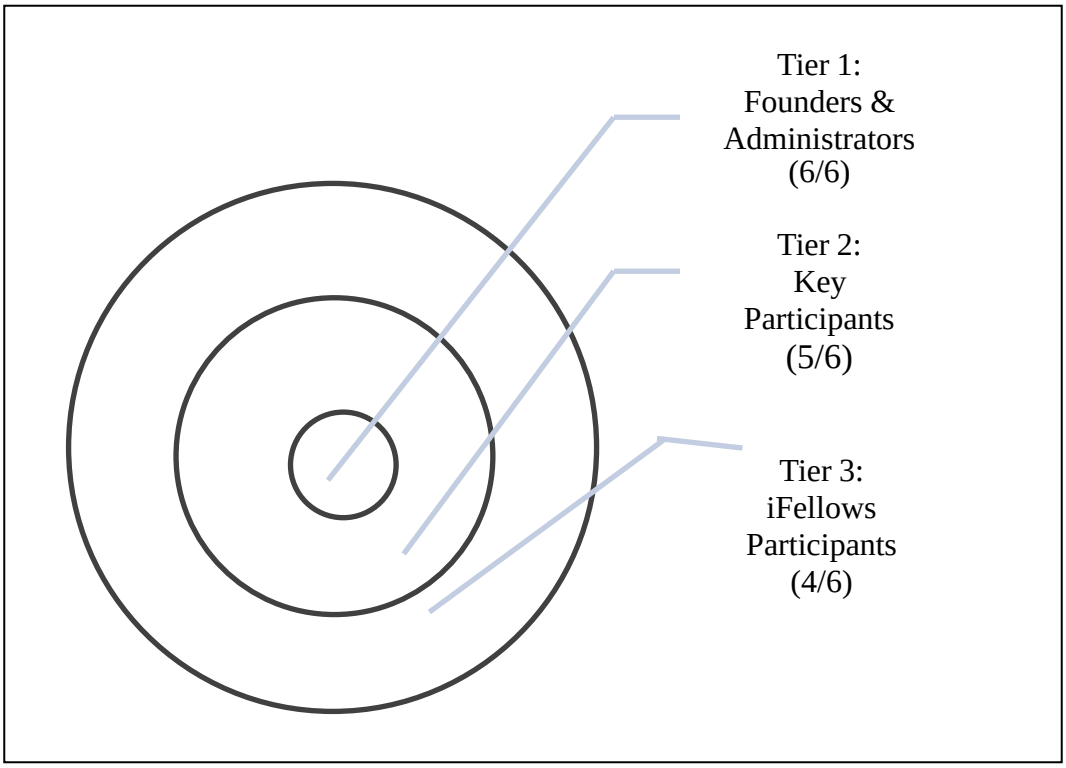

Figure 4 Distribution of faculty interviewees by participation tier (n=18)

Recruitment procedures began by sending emails to potential interviewees. Emails explained that the faculty member had been recommended by a co-director of iFoundry and offered an overview of the research project. A more detailed summary of the research project was attached to the email along with informed consent documents including a script and form to be signed by the perspective participant. Subsequent emails followed as needed to finalize recruitment, answer questions, and schedule the interview.

Fifteen semi-structured interviews were ultimately conducted. This represented 83% of the sample and 39% of the total iFoundry population. All six of the Tier 1 faculty were interviewed including two nonteaching administrators; two who shared teaching and

administrative duties, one engineering faculty and one faculty member from a discipline outside of engineering. Five of the six Tier 2 faculty gave interviews. These included two engineering faculty, two engineering deans, and one faculty with joint appointments in engineering and another discipline. Four of the six Tier 3 faculty were interviewed. Those interviewed included two engineering faculty and two faculty from other departments on campus. Five of those interviewed were members of iCouncil, the departmental liaison group, and 10 were Fellows. This tilted the weight of qualitative interview data toward the most active and involved incubator participants. The faculty who consented to interviews tended to have a long standing interest in engineering education with involvement in curricular affairs that pre-dated the curriculum incubator. Over half of those interviewed were engaged in on-going curriculum development projects.

Collection of data from interviews. Perceptions of the curriculum incubator were bounded by the duration of association, specific circumstances, intensity of participation (Strauss, 1998) establishing the need for open ended protocols that could be adapted during interviews in order to maximize understanding. For this reason interview processes varied. Interviews lasted from 44 minutes to 1 hour and 15 minutes. Initial questions probed the professional background, knowledge of iFoundry history, and acquaintance with incubator operations. Subsequent questions focused on the activities and interests of the interviewee.

Two interview protocols provided a flexible guideline that enabled all interviews to proceed in a relatively similar manner. The Tier I protocol was oriented toward faculty founders and administrators intimately knowledgeable about overall operations of the incubator. This group of individuals helped define iFoundry philosophy, organize operations, and worked closely with broad scale curriculum development issues. The protocol developed for Tiers II and

III tested the limits of participant knowledge of incubator processes and focused on the perspectives, contributions, perceptions, and interests of faculty who were making contributions to curriculum development but not generally involved in operations. Member checking was built into interview protocols and occurred during interviews as a way to verify findings and improve credibility (Creswell, 2003).

All of the interviewees agreed to be audio recorded. Two recording systems were used. A digital recording provided the basis of transcriptions while an audio tape served as backup. All interviews were transcribed; then identifying information was removed; the transcription was coded by the date of the interview, and a code was assigned. The transcription code identified the tier and an interview sequence number. An excel file served as the interview code key. The code key remained the only identifying link between interviewee and interview data. On the code key were the name of the participant, affiliation, date of interview, and transcript code. Audio recordings were deleted after transcription.

Quantitative design. While the nature of qualitative methods was emergent and grounded in interpretation of meaning and contexts (Patton, 1990), the quantitative method sought to test the presence of characteristics and effects postulated in the conceptual frame. Questionnaire design was informed by interviews and the conceptual frame functioned as a working hypothesis. Questionnaires introduced exactitude, measurement, and supported fidelity of the overall research design. In addition, some audiences may be more engaged by statistical descriptions. Survey questions were formulated to promote the measured presence of key descriptors and provide some understanding of the relative relationships of incubator components.

Research participants. Thirty-eight faculty affiliated with the curriculum incubator were potential respondents for the questionnaire. Incubator faculty represented 22 disciplines across campus. Twenty-five of the thirty-eight (66%) were affiliated with disciplines within the College of Engineering and thirteen faculty were from other disciplines across campus. IFoundry faculty were recruited by email. Emails briefly explained the dissertation research project and the informed consent procedures. Attached to the recruitment email was a more detailed summary of the dissertation research project and an informed consent document. Paper and pencil questionnaires were administered in two ways. Faculty who attended end of the year activities in May were given the opportunity to complete a questionnaire. Faculty who were not able to attend end of the year events received a copy of the questionnaire as part of a packet sent through campus mail. The packet contained a 6-page questionnaire, a description of the dissertation research project, an informed consent document, and a return envelope addressed to the Administrative Assistant in the I-Stem Office on campus. Once they arrived in the I-Stem Office, informed consent documents were separated from questionnaires in order to protect confidentiality.

Twenty-three of the 38 faculty returned the questionnaire resulting in a 61% rate of return. Sixteen (70%) of the 23 faculty who returned questionnaires were affiliated with engineering disciplines and seven represented other departments or organizations on campus. The group most responsive to the questionnaire was members of iCouncil. Fifty-four percent of iCouncil members returned the questionnaire.

Respondents were invited to indicate on a scale of 1(low) to 6 (high) their level of commitment to iFoundry. All respondents reported a high level of commitment (M = 4.30/6.0),

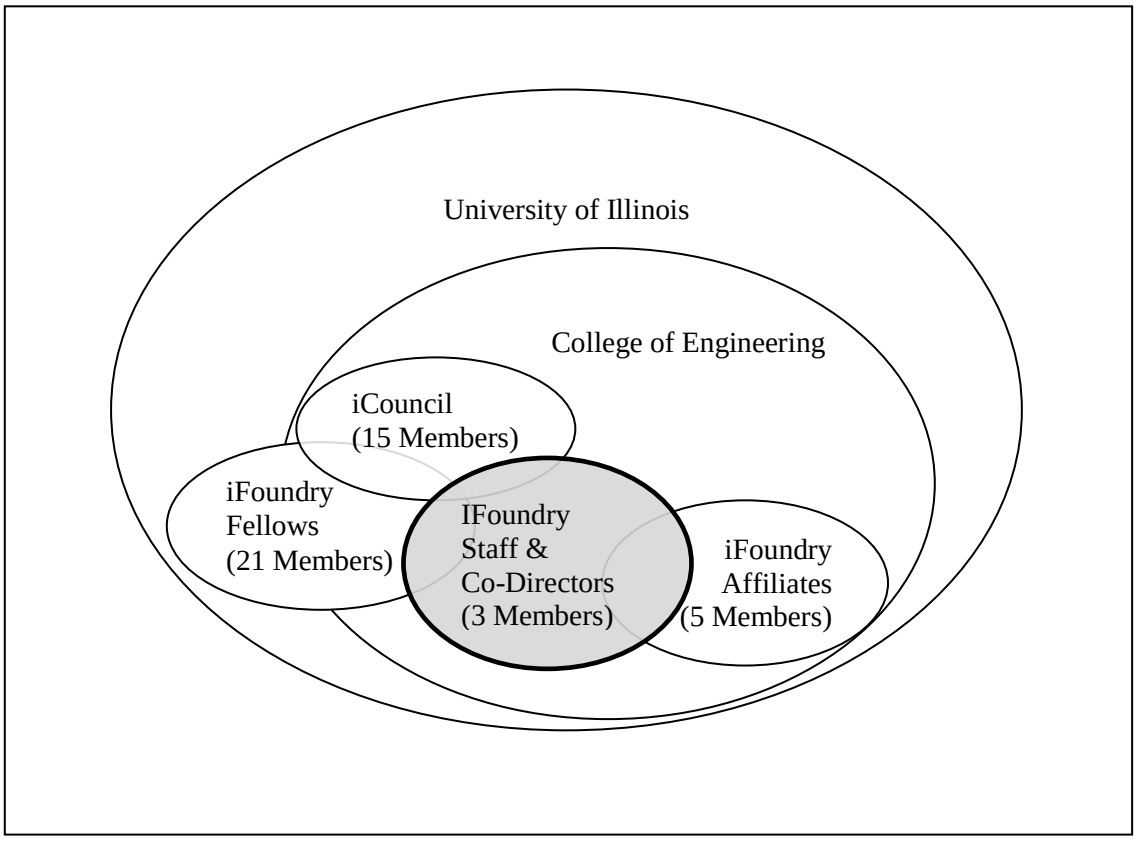

Figure 5 Diagram of organizational relationships for iFoundry

(*SD*= .926), (*p*< .05). Three respondents reported a commitment to curriculum research and development prior to the curriculum incubator launch in the Fall 2007. Fifteen reported a commitment beginning in either 2007 or 2008. Five faculty reported joining incubator activities in 2009. Members of iCouncil indicated the highest level of commitment (*M*= 4.67), (*SD*= .516), (*p*< .05) although the difference between commitment levels of subgroups was not significant.

Respondents were also asked to indicate on a scale of 1 (low) to 6 (high) their level of participation in iFoundry activities. Respondents reported an above average level of

participation, but the range varied (1-5) (M= 3.48/6.0), (SD=1.31), (p< .05) with 14 of 23 faculty indicating participation in two or more incubator activities. When asked about possible future

levels of participation fourteen respondents (60%) indicated a desire to increase

participation in the curriculum incubator. Eight indicated that limited participation was the result of time constraints imposed by other professional obligations. Of those eight, four anticipated becoming more active in the future. When respondents were invited to make open-ended comments on their responses, comments tended to be positive and short such as "Keep up the excellent work." Longer comments urged iFoundry to continue or expand relationships with departments. The following comment came from a faculty member within the College of Engineering. "Foundry is a great idea…[It] needs to get engaged more with Departments, so that Departments see it as a means to provide better education, better design experiences, and in general complimentary to their mission."

Encouraging comments such as the one just cited reflected ideas generally found in interviews. Engineering faculty affiliated with the curriculum incubator felt that participation was supportive of and complimentary to the educational mission of their department. Faculty from outside of the College of Engineering believed the interdisciplinary components of the incubator were helpful to their department and provided a model for curricular development activities in their own discipline. A faculty member outside of the College of Engineering summed up the value of interdisciplinary components of the incubator by making the following comment on the survey, "iFoundry is a model cross-college and cross-campus initiative. I am proud to be affiliated."

A few respondents wanted to increase their participation to learn more about outcomes of curricular research. For some this meant learning more about research conducted on engineering

courses and for others this meant learning how to assess their own courses in order to determine appropriate course improvements. Interview data confirmed this finding. During interviews some faculty expressed ideas for curriculum they felt would fill a gap or reconfigure content in ways that would better meet students' needs, but they weren't sure exactly how to evaluate those course outcomes. A tug and pull phenomenon was evident in the demographic data from the questionnaire and was supported by interviews. Faculty valued the contributions of the curriculum incubator and appreciated their connection to it, but felt some limitation on levels of commitment and participation due to other pressing professional responsibilities.

Instrument development. The questionnaire for this study was developed with five sections and was based on the conceptual frame for this study. Dimensions of organizational creativity were tested in sections 1-3. Items mimicked the Situational Outlook Questionnaire (SOQ) (Isaksen, Lauer, Ekvall, & Britz, 2001).

Developed and refined over 40 years beginning in 1967, SOQ was based on dimensions in the taxonomy of organizational creativity. The taxonomy defined variables in the climate of organizations that mediated the ability to create and innovate. By coupling emerging theory with field research, factor analysis, and consulting experiences, Ekvall (1967, 1971, 1991) first honed an instrument for commercial use called the Creative Climate Questionnaire (CCQ). That instrument has been widely studied for issues of reliability and validity (Talbot, Cooper, & Barrow, 1992; Lauer, 1994; Turnipseed, 1994; Cabra, 1996). About 10 years ago, Isaksen, Lauer, & Ekvall (1999) began further refinements to the taxonomy creating a newer instrument called Situational Outlook Questionnaire (SOQ). Claims for broader application of the SOQ instrument accompanied refinement. The newer instrument used 9 dimensions of organizational

creativity to test readiness for innovation and added a claim to assess readiness for change (Isaksen, 2007a). New claims for broader applicability have been examined in relation to

problem solving (Isaksen & Kaufmann, 1990; Isaksen & Lauer, 1999), support for creativity in organizations (Isaksen & Lauer, 2001), creativity in teamwork (Isaksen & Lauer, 2002), and most recently in transformative change (Isaksen, Lauer, Ekvall, & Britz, 2001; Isaksen & Tidd, 2006).

Since the SOQ is restricted to commercial use by registered consultants who pay for the privilege, the actual SOQ instrument was not used in this project. However, because the SOQ and its predecessor the CCQ have been widely tested and studied, a substantial body of literature documents the manner and mode of use as well as the accuracy and utility of dimensional factors. Development of the questionnaire for this dissertation study benefited from scrutiny of a substantial body of published reports, studies, and theoretical analysis of the SOQ. Information gleaned from these published reports was used as the basis to formulate Sections 1 on attributes, 2 on alignment to theories of change, and 3 on evidence for change. Contributing to questionnaire development were sample items in published studies cited in this dissertation, the 9 dimensions as documented by research, testing, field observations, and theoretical analysis, definitions and operational descriptions of the dimensions (Isaksen, Lauer, Ekvall, & Britz, 2001).

Items in the questionnaire used for this dissertation were modeled after the SOQ not identical to them. Items on the questionnaire diverged from the SOQ in important way. The Conflict dimension tested by Ekvall (1996, 1997), Isaksen, Lauer, & Ekvall, (1999); Isaksen, Lauer, Ekvall, & Britz, (2001), and Isaksen, (2007) focused on issues of ego, personal

opposition, and turf wars. The Conflict dimension was the only factor negatively correlated to other dimensions. In other words, less conflict enhanced creativity and innovativeness (Ekvall, 1996). Items in the SOQ that related to conflict asked respondents to identify areas of tension, negative use of power and so forth. During development of the questionnaire, wording of items that addressed conflict was difficult and the issues addressed seemed inappropriate to the audience. Cognitive interview testing bore out the dubious applicability of these items. As a result, the conflict dimension was reconfigured as a positive dimension and renamed Emotional Maturity. There were a couple of reasons this change seemed to improve the questionnaire. First, the dimension became a positive factor more in keeping with the appreciative orientation of this study. Second, the items immediately became user friendly, less threatening to the respondents, made them more likely to be answered, and more palatable to the audience for this study. Last, analytical diagrams that were produced for presentation of findings were able to indicate a clear and consistent picture of the presence of dimensions. High mean scores in all items consistently identified an organization ready for innovation and change.

This study claims theoretical support for items based on dimensions tested in the SOQ (Isaksen & Ekvall, 2006). Using SPSS, three reliability tests were completed to report overall scale and subscale internal consistency estimates for sections 1-3 of the questionnaire: (a) Each item was tested against the sum of all items; (b) Groups of 4 items in a subscale measuring each dimension of the SOQ were tested against each other; (c) Finally, each group of 4 items in the subscales measuring one dimension was tested against the sum of all items. Reliability testing using Cronback's Alpha revealed acceptable (.70 and higher) or good (.80) inter-item correlations (Gliem & Gliem, 2003).

When each item was tested against the sum of all items, alpha coefficient was .734. This indicated acceptable internal consistency. The scale was approximately 73% reliable at

measuring the same construct. It should be noted that lack of variability in the responses to item A1 caused SPSS to exclude the item. Twenty-two of 24 respondents score the item as a 4 (on a 4-point scale). Next, groups of four items measuring one dimension were tested against other groups of 4 items. This yielded a Cronbach's Alpha of .814 indicating that each group of 4 items was cohesive measuring the same dimension. Lastly, groups of 4 items were tested against the sum of all items to determine if each group of four contributed equally to the scale. This test yielded a Cronbach's Alpha of .757.

Each of the first three sections of the questionnaire just discussed addressed a research question or generated data that could be integrated for purposes of comparison, substantiation, and/or corroboration. The purpose of the survey instrument was to clarify characteristics and attributes, levels and limits of alignment to theories of curricular change, and the strength of evidence for incubator effectiveness. Section 4 tested the concepts of organizational behavior and incubation theory against other potential theoretical constructs: the theory of evolution and chaos theory. This section was developed by selecting 9 terms representative of each of the 4 theories and listing them arbitrarily on a single page of the questionnaire. Participants were asked to select 10 terms from the 36 listed they believed were most consistent with the attributes, characteristics, and key principles of the curriculum incubator. Section 5 collected demographic information and asked respondents to indicate on a scale from 1 (low) to 6 (high) their level of commitment to curricular change in engineering education . A separate question on the same scale asked for an indication of the respondent's level of participation in iFoundry.

After a draft instrument was developed, it was pretested through expert review, a process

where seasoned professionals in survey research reviewed and commented on the instrument (Hughes, 2004). The purpose of the review was to ensure items were interpreted as intended by respondents. In addition, pretesting permitted an estimation of the time needed to complete the questionnaire and allowed potentially confusing terminology to be reconsidered. Expert review has been found to be effective at finding potential problems, particularly problems with the potential to affect data analysis (Presser & Blair, 1994). Potential problems identified through expert review were modified and the new draft was subjected to five cognitive interviews.

Cognitive interviews are the most common form of pretesting for survey research (Tourangeau, Rips, & Rasinski, 2000). During cognitive interviews respondents were asked to think out loud describing their thought processes as they answered questions. Cognitive interviews were recorded and recordings were reviewed along with notes from the interviews. Cognitive interviews were helpful in refining the meaning and intent of items. Research has shown that cognitive interviews accurately and consistently identify potential problems with questionnaire items (Willis, Schechter, & Whitaker, 1999). Additional revisions were made in the instrument and it was tested for the last time on an incubator participant who was them removed from the respondent pool. Multiple methods of review were considered to increase the likelihood of discovering important problems with the instrument (Hughes, 2004) and offer opportunities to improve the instrument. The final instrument was 6 pages long and took about 15 minutes to complete.

Instrument overview. Sections 1 -3 of the questionnaire used Likert-style items formatted as a 4-point forced-choice response scale. Although items in each section were worded

to accommodate the focus of research questions, each item actually represented a dimension in the SOQ. Items in sections 1-3 were coded to identify a dimension on the taxonomy. Coding allowed items in each section to be grouped by dimension and analyzed accordingly.

Section 1, called Attributes, addressed research question 1 and contained 18 items, two from each of the 9 dimensions of the SOQ. Items described an attribute based on one of the 9 dimensions and asked respondents to indicate the applicability of that attribute to the incubator. Section 2, titled Personal Importance of Participation, contained 9 items based on the SOQ. Section 2 addressed research question 2 on the alignment of incubator processes to theories of curricular change. Respondents were asked to identify observed incubator processes and indicate the degree to the processes were personally important. The questionnaire presumed that items would not be indicated as important if respondents did not observe them as part of incubator mechanisms. Section 3, titled Evidence, addressed proof of curricular change using the 9 dimensions of the SOQ. Respondents were asked to indicate the degree to which an item indicated evidence for curricular change.

Section 4 of the questionnaire tested the relevance of conceptual frame against other theories of change. Section 4 contained 36 possible descriptors of the incubator. Out of the 36 descriptors, respondents were asked to identify 10 that most accurately characterized the curriculum incubator. Listed terms represented terminology associated with four theories of change: Incubation Theory, Organizational Creativity, Chaos Theory, and the Theory of Evolution and Adaptation. The theories were purposefully selected to represent concepts with the potential to resonate with the audience of engineers and other academics across campus. Incubation Theory was represented because the topic of the dissertation was curriculum

incubation, and incubation theory was part of the conceptual frame for the study. It was anticipated that engineers might identify with incubation concepts relating to business practices, development of new products and ideas for the marketplace. Two theories, Chaos Theory and the Theory of Evolution and Adaptation, represented models of change with potential to inform incubator activities. Chaos Theory and the Theory of Adaptation and Evolution were anticipated to resonate with engineers because of their scientific origins. No terms representing traditional curricular change were used in section 4 because interview data did not provide evidence that theories of planned curricular change were analogous to incubator activities.

The terms representative of each of the four change theories (Incubation, Chaos, Evolution and Adaptation, and Organizational Behavior) were selected from literature associated with each topic. Terms associated with Chaos Theory were derived from O'Connor & Robertson, (2003), Trump (1998), and Gleick (1987). Readings in evolution came from Fischer (1999), Holland (1992) and Kilman & Johnson (2005). The literature relating to incubation and organizational creativity was reviewed in the Literature Review of this dissertation. Review of the literature on Chaos and Evolution was admittedly superficial compared to the research conducted on incubation and organizational creativity. Terms from each theory were selected with intentionality on the basis of two criteria. First, terms were selected for inclusion in the questionnaire if qualitative information indicated a potential for applicability. Second, a term was selected for inclusion if it was commonly associated with one of the change theories.

During cognitive interviews, the difficulties of verifying the appropriateness of using terminology out of context became apparent. Out of context, terms lost some of their descriptive power. The decision to proceed with the use of terms used out of context was predicated on the fact that all of the terms on the forced choice list were out of context and so the descriptive

power of each term was jeopardized equally. Aside from collecting demographic data in Section 5 respondents were given the opportunity to make whatever comments.

Data Analysis

Data for this study were analyzed in three phases: (a) Early analysis of interview data involved determining themes which could be further probed in a questionnaire; (b) Statistical analysis of the questionnaire involved calculating descriptive statistics and an analysis of variance (ANOVA) to compare means in subgroups; (c) Interview data was re-analyzed in light of findings from the questionnaire to check major themes against questionnaire finings thus merging the data. This third analysis proceeded to merge findings from interviews and the questionnaire and reevaluate results. The purpose of using three phases of analysis was triangulation (Denzin, 1978). Comparison of findings from the two methods furnished either confirming or disconfirming evidence. The primary advantage of this two phase process was to provide some flexibility in the investigation so that analysis and finds could proceed naturally from the methods.

Collection and analysis of interview data. Analysis of interview data proceeded from transcripts although tapes and field notes were available to clarification purposes. Three basic steps for analysis were followed (Denzin & Lincoln, 2000).

1) Prepared the data for analysis.
2) Read through the data
3) Analysis by thematic coding

Initially, audio recordings were transcribed, identifying information was removed and each transcript was coded. The de-identified transcripts were read and notes were made in the margins to pinpoint potential themes. During this process research questions together with the theoretical frame for the study provided guidance. How did the faculty think about the curriculum

incubator? What attributes and characteristics were apparent to interviewees? Did comments of those interviewed illustrate any of the dimensions of organizational creativity or incubation theory? Did the faculty identify ways the curriculum incubator was achieving its goals? Or did comments indicate participants were thinking in different terms about the curriculum incubator? If so, what kinds of thinking about the curricular incubator were most apparent? During a second reading key comments were highlighted and assigned a code.

A second level of analysis occurred after the questionnaire was analyzed. Were the findings of the questionnaire consistent or inconsistent with interview data? Additional readings were aimed at developing an interpretative understanding of the individual reality of each interviewee and then coming to some conclusion about the collective realities of iFoundry members, how those perceptions relate and the relative importance of each to the holistic understanding of the curriculum incubator. Analysis was a labor intensive process requiring emersion in the data in order to avoid oversimplification of evidence (Jones, Torres, & Arminio, 2006). The process involved a combination of reflection followed by analytic questions to uncover meaning (Denzin & Lincoln, 2000). Analysis was completed with an eye toward believability, coherence, insight, usefulness (Eisner, 1991) and trustworthiness (Guba & Lincoln, 1994). Verification of findings proceeded from finding multiple similar responses from different interviewees. Member checking and triangulation became secondary sources of credibility.

Collection and analysis of quantitative data: attributes, alignment, and evidence. Data from questionnaires was analyzed in seven stages reflecting the various ways information could be aggregated to test research questions. Each section of the questionnaire was first analyzed separately. Section 1 provided information about faculty perceptions on the attributes, characteristics, and key principles of the curriculum incubator based on dimensions of the SOQ.

Section 1 items contained two questions which reflected concepts of the 9-dimensions of organizational creativity. Section 2 probed the personal importance of the incubator to respondents and provided evidence relating to the SOQ. Each of the 9-items reflected one of the 9-dimensions of organizational creativity. Section 3 addressed whether respondents saw evidence that the curriculum incubator was influencing engineering education and evidence of the presence of the 9-dimensions from the SOQ. Each of the 9-items reflected one of the 9-dimensions of organizational creativity. Data from these three sections was then merged and the aggregated data analyzed to determine alignment with concepts from organizational creativity, specifically the 9-dimensions of the SOQ. Merged sections resulted in four items addressing each of the 9-diemnsions of organizational creativity. In a fourth analysis aggregated data from sections 1-3 was compared to earlier studies on innovative organizations using the SOQ and conducted by Isaksen, Lauer, Ekvall, & Britz (2001).

Analysis included first recording individual responses to each question on a spread sheet. Responses indicated the level of agreement with items on a 4-point scale from weak (1) to strong (4). SPSS software was used to calculate descriptive statistics for single items, then the group of items reflecting the 9-dimensions of organizational creativity. The resulting mean scores identified the magnitude of each dimension for each research question. Finally, an Analysis of Variance (One-way ANOVA) was run for each research question to test for significant differences in means among sub-groups in the population. Comparisons were made between subgroups of engineers, non-engineers, and iCouncil. Although the underlying assumptions for using ANOVA were met, the sample size was less than 100 and the findings were not robust. Lastly, mean responses for each research question were plotted on a spider chart indicating

graphically the comparative presence among the nine dimensions on the SOQ taxonomy for each research question.

Analysis of merged data. Aggregated data from sections 1-3 was used to create a description of the environment for curriculum change. Descriptions reflected the magnitude and presence of 9 dimensions of organizational creativity as conceptualized by the SOQ taxonomy. Each of the 9 dimensions described the incubator environment and processes.

Information from qualitative and quantitative sources was merged in a graphic depiction by summarizing themes and quantitative findings. This pictorial analysis provided a comprehensive description of iFoundry characteristics, alignment to change theory, and evidence of iFoundry influence.

Aggregated data was mapped on a spider chart according to the dimensions of organizational creativity. Added to the spider chart was aggregated data from earlier research on 10 innovative organizations actively engaged in successful change and 5 stagnated organizations engaged in unsuccessful organizational change (Isaksen, Lauer, Ekvall, & Britz, 2001).

Collection and analysis of data: section 4. Instructions in section four asked respondents to select from among 36 terms ten that were most descriptive of incubator activities. The list was composed of nine terms from each of four theories of change: Incubation Theory, Organizational Creativity, Chaos Theory, and the Theory of Evolution and Adaptation. Findings were analyzed by counting votes for each term, then tallying the total number of votes received. Terms were ranked according to votes received. Additional analysis was provided by grouping terms according to theory and calculating cumulative totals for each theory. Calculations permitted comparisons of the kinds of change processes identified by respondents and provided corroborating evidence for research question 2 about alignment to theories of change.

Cumulative totals representing each theory were then plotted on a bar chart and ranked according the number of votes received. A spider chart was used to create a graphic comparison of the votes received.

Collection and analysis of data: section 5. Individual demographic data was entered on an Excel spreadsheet and cumulative totals were calculated for the entire set of data. Self-reported levels of commitment and participation were recorded on an Excel spreadsheet and the mean level of commitment and participation were calculated. A few faculty provided open text responses which were recorded on an Excel spreadsheet.

Advantages and Limitations of Research Design

Individual and synergistic effects from two methods provoked insights and conveyed a more thorough analysis (Green, Caracelli, & Graham, 1989; Miles & Huberman, 1994; Green & Caracelli, 1997; Tashakkori & Teddie, 1998). A mixed methods sequential transformative design (Tashakkori & Teddie, 1998; Creswell, Plano. Gutmann, & Hanson, 2003) involved using separate phases if data collection. Sequential procedures contributed to the organization and implementation of the research design, although the design was time intensive and challenging to complete over a short data collection period. In the case of this study, qualitative analysis occurred in two parts. One challenge in conducting this research project was finding studies to use as guides for moving between phases, co-joining analysis and findings (Hanson Creswell, Plano Clark, Petska & Creswell, 2005; Tashakkori & Teddie, 2003). Preliminary analysis of interview data was conducted in March with the goal of focusing items on the questionnaire and again in June-July to provide stand alone and finally confirming or disconfirming data from questionnaires.

The goal of this research design was to provide flexibility that would enhance a holistic determination of curriculum incubator processes as seen through the eyes of participating faculty. Although preliminary background and contextual information was supplied through observations and document review, careful efforts were made not to formulate any predetermined expectations (Creswell, 2009; Patton, 2002). The research design was strengthened by inductive processes including active collaboration with the participants, the organization and re-organization of information until comprehensive understanding is achieved (Creswell, 2009). The use of a standardized tool for measuring organizational creativity, the Situational Outlook Questionnaire (SOQ) (Ekvall, 1996) benefited this research in at least two ways. The SOQ is an instrument developed an d refined over 25 years of research. The SOQ has the potential to assess organizational climate which supports change, innovation, and creativity (Isaksen, 2007). The subscales relating to the organizational dimensions of change, innovation, and creativity provided a useful taxonomy for identifying characteristics, attributes, and principles of the curriculum incubator.

For a couple of reasons the original SOQ could not be used for this study. The SOQ is owned by a consulting organization called The Creative Problem Solving Group, Inc. and not available for personal use. In addition, the SOQ was formulated for use in a business organization rather than an educational organization. The scale developed for this dissertation research is similar and was developed based on published studies and descriptive analysis of the scale. The similar scale developed for this dissertation research was created over 3 months. Reliability testing for the similar scale revealed Cronback's Alpha calculations somewhat lower than those published for the SOQ (Isaksen, 2007). The scale developed for this dissertation

project would benefit from additional item analysis, test-retest reliability, and perhaps some item refinement based on those results.

A major limiting factor in this research design was the size of the population studied. This project will be challenging to replicate although the assertions contained in this project would benefit from additional scrutiny. The curriculum incubator membership was small and incubator processes were emergent. Another limiting factor was the focus of the research questions on faculty only. Data from students or other partners was not collected, nor was information from faculty outside the incubator, administrators, or other constituents. A major reason for limiting the participant pool was the early stage development of the curriculum incubator. As the incubator develops, more faculty, students, and other constituents become involved, data drawn from a larger population will provide important information. In the future, the incubator would benefit from further research using both inductive and deductive processes.

Because of the early developmental stage of the incubator longitudinal information was neither available nor relevant. The curriculum incubator was an emerging program, logic dictated that early documentation of processes be more holistic and inclusive, encapsulating inductive arguments of naturally occurring processes (Krathwohl, 1998). In the future further research could verify results and contribute to the generalizability of results.

Chapter IV

Results

Research Question 1:
What are the Attributes, Characteristics, and key Principles of the Curriculum Incubator?

The curriculum incubator existed in two interrelated dimensions. First the incubator was an entity that engaged in curriculum development activities. Secondly, the incubator was a process that negotiated organizational change. Curriculum development activities were readily apparent, observable. Faculty could see and participate in activities and courses within the incubator. Faculty participants in curriculum development had a grasp of the attributes, characteristics, and principles that defined the incubator environment. They could identify these attributes in conjunction with curricular activities. But, the second dimension, the longer term organizational change piece, was more difficult to identify. Faculty participants in the incubator seemed uncertain how curriculum development activities were going to result in sustainable longer term curriculum change. Bit and pieces of the organizational change process emerged in many interviews, but it was clear that during this formative stage of iFoundry faculty were still glazing over some of the steps toward change. A faculty member in Tier 1 described the process this way:

> We're developing new courses and piloting them, and if they show some signs of success based on student interest and student results and there's an opening in the existing curriculum for them to be put into that, that's how that works. If you want to call that an incubation process, fine.

Among the bits and pieces that were recognized by faculty was the necessity for long term curricular change. Many faculty recognized the need for sustainable curricular change and recognized the difficulty of making change sustainable.

> [The leaders of iFoundry] have taken a very realistic view of higher education and how it reacts to change—how change occurs and doesn't occur…their change is not only creating something new—it is creating something new that will last over time. The second one is much harder than the first. They are looking for that. They are looking for something that lasts over time. Something enduring.

Many faculty saw informed decision-making as key to sustainable change. The incubator relied on small piloted courses making each course a small experiment. Testing curricula involved data gathering, assessment, and informed decision-making. An informed process was viewed as a key to sustainable change. The following quote was from a participant in Tier 2 who was deeply involved in incubator activities. This quote illustrates the role of experimentation an important characteristic of incubator activities and recognizes processes that support the leap from productive experimentation to sustainable change.

> The way I think about the iFoundry curriculum incubator is that it is a space where students have permission to try things without endangering their potential for earning a degree. They can say 'I would like to take some class instead of a required class' and still know that for example—'I am going to get a Civil Engineering degree after being here.' So it reduces the risk for students and from our stand point—from an educators standpoint it gives us a chance to collect some data to see how things work. Instead of the usual process where you imagine a curriculum and you write the changes and it goes through a whole hierarchy of approval up to the Board of Higher Ed and then after all that is done, the first student goes through.

Incubation or pilot testing of proposed curricula together with evaluation/assessment of student outcomes was an important piece of the curriculum incubator. Assessment of incubated courses and programs made changes deliberate, intentional, and based in factual analysis rather than opinion. Routes through traditional curricular change seemed abstract beside the more concrete development and testing of curricular ideas.

> Instead of saying here is a proposed curriculum please, faculty vote on it. We will instead get a waiver for 100 students take them through for 4 or 5 years and give you concrete results that are measurable results. Here is what happened. Here is what worked and here is what didn't work. That to me is the correct thing. To me the key step is to vote on the actual results.

Along with informed decision-making goes the necessity to sustain change as faculty revamp the approach to a course. One insightful faculty member put it this way:

> [There is] certain squeamishness about [change] not because [faculty] don't think change is important but… well, a few people are bold enough to raise their hand and say, 'we don't know how to do this.' [That isn't true] you don't survive in this system unless you are really exceptional – they might need to put a little time into thinking about how to do it…trying it a few different ways… these are interesting, creative people, you give them some freedom to exercise…and I think that would be it.

It took more effort for faculty to identify characteristics that were part of sustainable organizational change, but all of the faculty interviewed could readily enunciate characteristics that were representative of curriculum development activities. As interviews progressed a consensus on the characteristics of curriculum development seemed to emerge. Faculty were bright, talented, and creative. So were students. To be effective the curriculum incubator needed to leverage those characteristics in an environment that embraced a variety of ideas and approaches to teaching and learning.

In the final analysis of interviews, twenty-four attributes of curriculum development were identified (see Figure 6). These attributes defined an environment in which curriculum development occurred. By reviewing the operational definitions of the 9 dimensions of Organizational Creativity it was possible to compare attributes generated by interviews to the dimensions of organizational creativity. But, it was not possible to determine if some attributes

were similar or if any would be considered more applicable to incubator activities than others without looking further at data from the questionnaire. (See Table 3)

Collaboration & Cooperation	Permeable Boundaries
Voluntary Participation	Safe Supportive Environment
Respect for Faculty Governance	Experimentation & Evaluation
Administrative & Departmental Support	Entrepreneurial
Student Involvement	Multiple & Diverse Perspectives
Strategic Partnerships	Exploration & Risk-taking
Transparent & Inclusive Processes	Inspiring
Leverage Research & Existing Knowledge	High energy
Climate of Trust	Humanistic
Conversations & Debate	Chaotic
Adaptive & Opportunistic Responses	Interdisciplinary
Cross Pollination of Ideas	Thoughtful, reflective

Figure 6 IFoundry attributes based on qualitative analysis of interviews (N=24)

Items in the questionnaire were grouped according to each of the 9-dimensions of organizational creativity. In Section 1 there were two items on each of the 9-dimensions. The mean was calculated for the two questions relating to each dimension and the dimensions were ranked. Faculty responding to the Section 1 of the questionnaire ranked most highly the attribute of Idea Time. This characteristic refers to the amount of time available to consider and test new ideas (See Table 6). A high mean score indicates that opportunities exist to explore and develop

new ideas without the pressure to find the "right" answer on the first try. High pressure environmnts and those environments where every moment is scheduled make thinking outside of normal work routines difficult and not conducive to organizational change (M= 3.77/4.0) (SD = .43) ($p < .05$). The fact that Idea Time was ranked highest indicates that faculty participants in the incubator believe that the presence of the incubator provided time to think about curricular alternatives.

Ranked second was the attribute of Playfulness and Humor. This dimension measured the ability to find joy in work. A work environment dominated by gloominess and stiffness is indicative of a workplace where people take themselves too seriously. The high mean score on this dimension indicates a certain amount of spontaneity and humor. Faculty found the incubator environment to be a relaxed work environment and one that enabled members to engage in curricular exploration without the pressure to get it right the first time (M =3.64/4.0) (SD = .58) ($p < .05$).

The attribute of Conversation and Debate was ranked third. The presence of a willingness to engage in conversation and debate allows a diversity of perspectives to be shared which in turn generates creative connections of new ideas. The ability to engage in open debate and accept many different viewpoints is considered central to change efforts. More authoritarian organizations tend to have less debate and conversation while more open organizations encourage people to contribute viewpoints and share ideas freely. The incubator's high mean score indicated an open environment amenable to sharing of ideas, considering alternatives, and accepting new ideas with potential (M = 3.60/4.0) (SD= .67) ($p< .05$).

Ranked fourth was the attribute of Idea Support. This characteristic relates to the way new ideas are received. In an environment supportive of new ideas, suggestions are received in

Table 3

Ranked Perceptions of Incubator Attributes By Dimensions of Organizational Creativity (Scale 1-4)

Ekvall (1996)/ Isaksen (2007) Dimensions	**Mean**	**Standard Deviation**
IDEA TIME Opportunity to explore and develop new ideas; atmosphere of flexibility	3.77	.43
PLAYFULNESS/HUMOR Atmosphere of spontaneity, light-heartedness	3.64	.58
DEBATE Sharing different experiences and knowledge	3.60	.67
IDEA SUPPORT Openness to new ideas; exploration Of new ideas; diversity of perspectives	3.57	.67
EMOTIONAL MATURITY Psychological insight; emotional maturity	3.55	.60
CHALLENGE/INVOLVEMENT Intrinsic motivation, commitment, joy, & meaningfulness	3.54	.60
RISK-TAKING Tolerance of uncertainty, ambiguity; willingness to gamble on new ideas	3.50	.76
TRUST/OPENNESS Trust, mutual respect & support	3.33	.74
FREEDOM Individual freedom to pursue interests	3.27	.71

an attentive, professional, and positive way. Listening to the ideas of others is valued. All ideas are considered for their potential to contribute to the organization. 'No' is not automatic and destructive negative arguments are rare. A high mean score on this dimension indicated that within the incubator new ideas were given opportunities to develop before judgment about their merit occured (M= 3.57) (SD = .67) (p< .05).

Next was Emotional Maturity. This attribute refers to the presence or absence of conflict and interpersonal warfare. Organizations high in emotional maturity have members who exhibit psychological insight and impulse control. Fewer personal differences erupt into political battles or power struggles. The high mean score of the incubator indicated genuine cooperation, collaboration, and helpfulness among members. These characteristics are foundational for organizational change because change will not be sustainable unless everyone is involved (M =3.55) (SD = .60) (p< .05>).

The attribute of Challenge and Involvement relates to whether people are intrinsically motivated and committed to the work of the organization. Environments high in this attribute are populated by people engaged with their work. Members sincerely want the organization to succeed. The high mean score of the incubator indicated that members took joy in their work and were highly invested in making the incubator successful. (M = 3.54) (SD = 6.0) (p< .05).

Risk-taking involves the ability to tolerate uncertainty and ambiguity. Tolerance for risk-taking is necessary for organizational change since change involves facing the unknown. In risk-avoiding environments, people don't tend to put new ideas forward relying instead on diverting responsibility or covering themselves. Such over cautious environments rarely come up with bold new ideas. The mean score of the incubator on this dimension indicated the presence of a high level of boldness and willingness to accept new ideas (M= 3.5) (SD =.76) (p< .05).

The attribute of Trust/Openness describes the level of emotional safety present in an organization. High trust and openness supplant suspicion and cautiousness. Organizations high in the characteristic of trust share ideas freely. Communication is open and sincere. Respect

dominates relationships. The mean score of the incubator signified an open environment where people counted on each other for support and encouragement (M = 3.33) (SD= .74) ($p< .05$).

The attribute of Freedom reflects the level of individual independence felt by members of the organization. The dimension measures the degree to which members perceive they have freedom to take initiative, to define much of their own work, and to exert independence of behavior. Organizations which exhibit low levels of Freedom tend to have strict and rigid guidelines for work. Tasks are prescribed and there is little room for independent judgment. The relatively high mean score in individual freedom indicated by members of the incubator is evidence that the incubator accepted members as autonomous beings capable of defining their roles and the scope of their work (M = 3.27) (SD = .71) ($p< .05$).

Analysis of these 9 data points revealed high mean scores in all dimensions. Mapping the data on a spider chart revealed the strength of the findings (See Figure 7). This configuration of data was indicative of an organization high in characteristics that lead to change, in this case, curricular change.

Once the hierarchy of 9 dimensions of organizational creativity were created attributes developed through interviews were overlaid in a comparative analysis. This represents the merger of Figure 6 and Table 3. (See Table 4) Terms listed in bold represent the 9 dimensions of organizational creativity. Terms listed just below each bolded item represent thematic attributes identified by faculty during interviews.

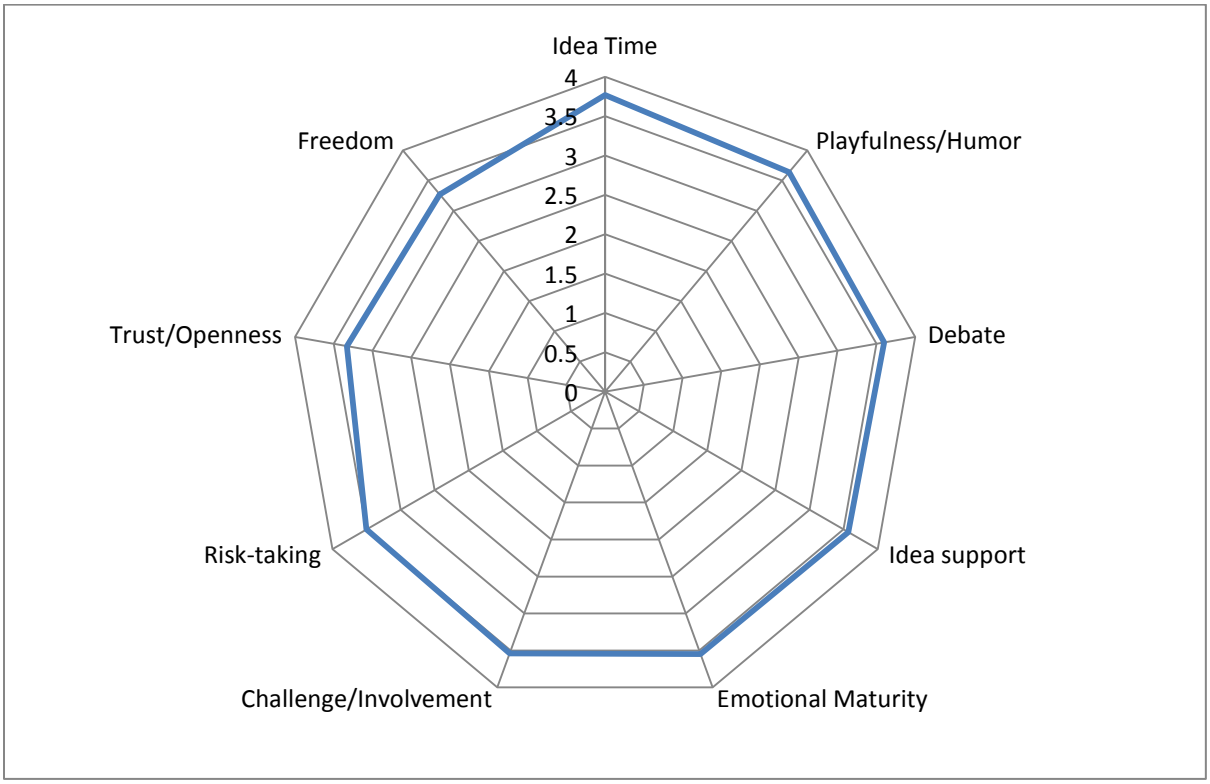

Figure 7 Scoring patterns of incubator attributes based on dimensions of organizational creativity

Although faculty seemed to agree that the dimensions of organizational creativity described incubator activities, the question still remained as to whether organizational creativity was the best descriptor of the incubator change mechanism. The way to obtain an answer was to look at other theories of change and determine if other theories of change might better describe incubator attributes. In the questionnaire, faculty were asked to identify descriptors representative of other change theories and determine if those descriptors were attributes of the incubator. Descriptors representative of Organizational Creativity, Incubation Theory, the Theory of Adaptation and Evolution, and Chaos Theory provided descriptors. Of the top 12

Table 4

Comparison of Interview Identified Attributes to the Nine Dimensions of Organizational Creativity

Opportunity to explore and develop new ideas; (Idea Time)
- Cross Pollination of Ideas
- Thoughtful, reflective
- Leverage Research & Existing Knowledge

Atmosphere of spontaneity, light-heartedness (Playfulness & Humor)
- Inspiring
- Chaotic

Sharing different experiences and knowledge (Debate)
- Conversations & Debate
- Interdisciplinary
- Strategic Partnerships

Positive constructive attention to new ideas (Idea Support)
- Collaboration & Cooperation
- Student Involvement
- Experimentation & Evaluation

Psychological insight; absence of conflict (Emotional Maturity)
- Safe Supportive Environment
- Multiple & Diverse Perspectives

Intrinsic motivation, commitment, joy, & meaningfulness (Challenge & Involvement)
- Voluntary Participation
- High energy
- Humanistic

Tolerance of uncertainty, ambiguity; willingness to gamble on new ideas (Risk-taking)
- Adaptive & Opportunistic Responses
- Exploration & Risk-taking
- Entrepreneurial

Trust, mutual respect & support (Trust/Openness)
- Respect for Faculty Governance
- Administrative & Departmental Support
- Climate of Trust

Individual freedom to pursue interests (Freedom)
- Transparent & Inclusive Processes
- Permeable Boundaries

attributes selected as characteristic of incubator activities, descriptors relating to organizational creativity were identified most consistently (5/12) and received the highest ranking. Descriptors relating to the Theory of Adaptation and Evolution followed (4/13). Descriptors relating to Chaos Theory ranked third (2/12). Incubation Theory ranked lowest (1/12). Table 5 lists the 12 descriptors identified most frequently, the number of votes received and the related change theory.

Table 5

Top Twelve Ranked Characteristics and Aligned Change Theory

Characteristic (12)	Number of votes	Theory of Change
Participant oriented	18	Organizational Creativity
Collaborative development of new ideas	15	Organizational Creativity
System for innovation	14	Organizational Creativity
Crossover of ideas	14	Evolution & Adaptation
Enabling process	11	Incubator Theory
Adaptation to circumstances	11	Evolution & Adaptation
Diverse possibilities	10	Evolution & Adaptation
Navigating complex challenges	10	Organizational Creativity
Variety of opportunity	10	Evolution & Adaptation
Small changes- big effects	9	Chaos Theory
Accepting of uncertainty	9	Organizational Creativity
Unpredictable trajectory	8	Chaos Theory

Merging the attributes. A comprehensive list of 45 characteristics was generated by merging the three sources of attributes: Interviews, Questionnaire Sections 1-3, and Questionnaire Section 4. At first glance the merged lists appear to be just a comprehensive list with some terms from different sources duplicated or similar. Further qualitative analysis led to the identification of four themes relating to the characteristics of the curriculum incubator. The four major themes or characteristics were: (a) Incubator activities relied on transparent and inclusive processes. (b) Participation was voluntary and collaborative. (c) Exploration and experimentation of alternatives was key. (d) Processes involved evaluation of alternatives and adaptation that embraced opportunity (See Figure 8).

Rather than being a list of discrete attributes, interviews indicated that faculty did not perceive of incubator descriptors as disparate but as overlapping, related, connecting, supporting and informing each other. For example, the attribute of collaboration emerged from all three sources of data. Reviewing the interviews it became apparent that faculty did not view collaboration as distinct from other characteristics, but related to them.

> [The curriculum incubator relies on] philosophical reflection [which] for me means stimulating conversation – the kind of cross-disciplinary boundaries. It sort of goes back to this idea of a collaborative incubator ideal, if you bring a bunch of people together from across all disciplines you get a much richer conversation than if you're just sort of talking within your own [area].

These two sentences echo of at least eleven characteristics from the list of 46. Here the faculty member links characteristics in ways that create more dimensional attributes: thoughtful and reflective processes, listening, conversations, inspiration, permeable boundaries, collaboration, openness to ideas, multiple and diverse perspectives, interdisciplinary, inclusivity, cross

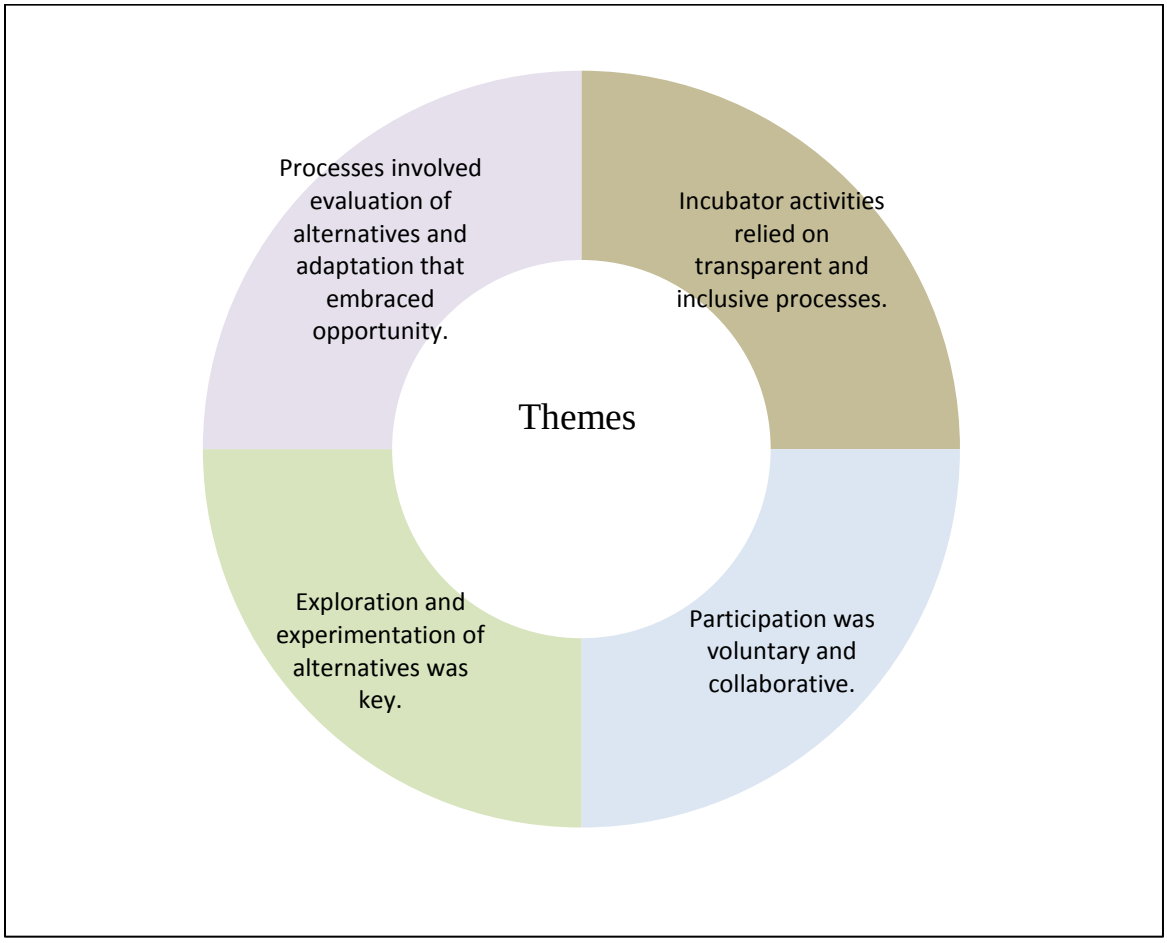

Figure 8 Major characteristics of the curriculum incubator

pollination of ideas, strategic partnerships. It is clear that for this faculty member those characteristics overlap and function interdependently.

Another faculty member made similar connections to collaboration but viewed those connections in a slightly different light. Here the refrains of collaboration are linked to inclusivity, interdisciplinary, diverse perspectives, and collaborative development of new ideas, strategic partnerships, and variety of opportunity.

> [The curriculum incubator is] very inclusive. I love the way so many people at all levels, faculty through students, and academic professionals all over campus, all majors participate. Having people participate from fine and applied arts and other places [is wonderful]. So it is very inclusive and diverse both on and off campus. We have industry partners and people who hire our students. All those are involved.

Still a third faculty member linked collaboration to the dynamic functioning of the curriculum incubator:

> …the benefit of trying a few new things is to infuse a sort of a new energy and a new enthusiasm, a new kind of a satisfaction in trying some new things. [IFoundry activities are] energetic and daring. Inspiring partnerships are a big part of what we're trying to do. We need to build partnerships with the departments, faculty; partnerships off campus. There's definitely a certain kind of building community that's part of our job.

These brief sentences resound with linkages of collaboration to other characteristics like energy, inspiration, exploration and risk-taking, and strategic partnerships. In fact qualitative analysis revealed widespread agreement on incubator attributes. Although qualitative data inevitability led to the identification of many descriptors, the key characteristics of those descriptors distilled into four themes. (See Figure 8) Using the four themes and eliminating identical or redundant items, a list of 26 attributes was identified. Table 6, below, identifies the attributes. Interestingly, the goals of the curriculum incubator as identified by incubator leadership were congruent with attributes uncovered through research. Such congruency was interpreted as indicative that uniform concepts permeated the incubator at all levels of participation.

Although attributes from the three sources of data fell into four themes, attributes from difference sources tended to cluster differently. Attributes generated from change theories, for example, tended to cluster around the theme of Adaptation and Exploration. Attributes generated from qualitative analysis of interviews were evenly distributed among the four themes. Attributes generated from the SOQ clustered around the themes of Adaptation and Exploration spilling over

slightly into the theme of Experimentation and Evaluation and the theme of Voluntary and Inclusive Participation. The ramifications of these clusters will be discussed further in the findings of the second and third research question.

Table 6

Attributes of the Curriculum Incubator Identified by Faculty (n=20)

Participant oriented	Complex challenges
Psychological insight, emotional maturity	Conversations & debate
Risk-taking	Diverse possibilities
Safe supportive environment	Enabling process
Small changes big effects	Entrepreneurial
Strategic partnerships	Freedom to pursue interests
Thoughtful & reflective	High energy
Tolerance of uncertainty	Humanistic
Trust & mutual respect	Innovative
Unpredictable trajectory	Inspiring

Though attributes from the three sources of data fell into four themes, attributes from difference sources tended to cluster unevenly. Attributes generated from change theories, for example, tended to cluster around the theme of Adaptation and Exploration. Attributes generated from qualitative analysis of interviews were evenly distributed among the four themes. Attributes generated from organizational creativity (SOQ) clustered around the themes of Adaptation and Exploration spilling over slightly into the theme of Experimentation and Evaluation and the

theme of Voluntary and Inclusive Participation. The ramifications of these clusters will be discussed further in the findings of the second and third research question.

Research Question 2:
How do the Characteristics of the Curriculum Incubator Align to Theories of Curricular Change?

During interviews three things became apparent. (a) Faculty were not interested in traditional paths to curricular change. Faculty had seen previous efforts geared toward curricular change fail. The failed efforts tended to be oriented toward convincing faculty that a certain curricular plan was best. Incubator participants wanted curricular changes to emerge from testing, collective understanding and acceptance. (b) The exact configuration and content of curriculum was less important than finding a way to engage students on a deeper level. Incubator participants believed in the ability of fellow faculty to deliver quality content regardless of the course configuration or format. (c) Effective and sustainable curricular change had to focus on creating an environment that found challenge and joy in contribution and new ideas. Incubator participants wanted curricular development activities to be a rewarding experience for all members. The prevalence of these ideas in interviews made the possibility of alignment to curricular change theory a remote possibility,

Traditional curricular change was viewed with skepticism. As it is outlined in the literature and implemented in many institutions, traditional curricular change relies on planning and review rather than empirical evidence. Faculty who participated in the curriculum incubator viewed traditional curricular change as heavily reliant on influence as opposed to evidence. Planning processes seemed more reliant on opinion and less credible than curriculum that has been incubated and tested on students. Faculty involved in the incubator didn't have a final vision of the future curriculum. One faculty member put it this way:

> iFoundry really started from the organizational problem. If you look at a lot of engineering education transformation efforts they start from the plan. I am really tired of the plan. So [everybody has their plan] then if you look at the effect of those changes most of them have not diffused. It seems to me people need to think more deeply about the organization. You need to start from the organization…People ask me about the plan. I want to talk about the process not a plan.

The implication was that with traditional methods experimentation happens after a course is already an approved part of the curriculum. Incubator processes reversed this pattern allowing curricular ideas to undergo testing and development before being introduced into the curriculum. Based on this approach, incubator processes seemed more emergent rather than planned and executed.

Secondly, faculty indicated that the exact configuration and content of courses was less important than finding an appropriate structure and ways to engage students. For example, during the initial pilot of a new freshman experience course, the emphasis was on identifying key elements that should be included in the course. Five such elements were identified through research during the initial pilot phase: concentration on basic skills; experiencing joy in learning; creating an identity as an engineer; offering opportunity for choice; and honoring personal aspiration. A faculty member put it this way:

> We put a structure around what we did in that first course and we focused on key [ideas]. We created an identity around being an engineer by letting them experience what engineering was really like outside of the classroom. We let them know that we would honor their choices and aspirations. We didn't start out with this model, but we found it because we had a concept and a theory behind what we were doing.

Although it was not specifically identified by this incubator participant, it was clear from this and other interviews that respect for the ability of faculty ability to make meaningful contributions was foundational to the characteristics of the incubator.

It was clear from the beginning of interviews that core faculty in the incubator viewed the curriculum change process as an organizational problem rather than an issue of curricular content. One of the incubator founders put it this way:

> Lots of people have tried the salami approach to change in education. If you change enough classrooms you have changed the system. That is not actually true unless you have the integrated notion of change. We really started from the organizational problem. If you look at a lot of engineering education transformation efforts they start from the plan. I am really tired of the plan. The fundamental problem is organizational. You are not going to get anywhere unless you tackle that.

Incubator faculty wanted to create sustainable change. Activities of the incubator were geared toward creating an environment that found change a creative and stimulating endeavor.

The prevalence of these ideas in interviews made the possibility of alignment of incubator processes to traditional theories of planned curricular change a remote possibility. If traditional curricular change processes were not applicable to incubator activities, additional research for this dissertation had to focus on determining what kind of change model was at work.

The conceptual frame for this project posed a working hypothesis that integrated incubation theory with organizational creativity as the model for incubator activities. Survey data provided an opportunity to explore alternate theories of change. When faculty were allowed to select 10 descriptors from among 39 terms representing four theories of change, the vote was overwhelmingly in favor of organizational creativity. A total of 223 votes were cast by faculty participating in the questionnaire. The descriptors most frequently selected originated from the Model for Organizational Change, the change model most closely associated with organizational creativity (92/223) (41%). The Theory of Evolution came in second (58/223) (26%). Incubation Theory came in third (40/223) (18%). Chaos Theory came in fourth (33/223) (15%). Table 4.4

illustrates the finding. These results indicated that faculty participating in the incubator viewed incubator activities as primarily aligning to theories of creative change. (See Figure 9)

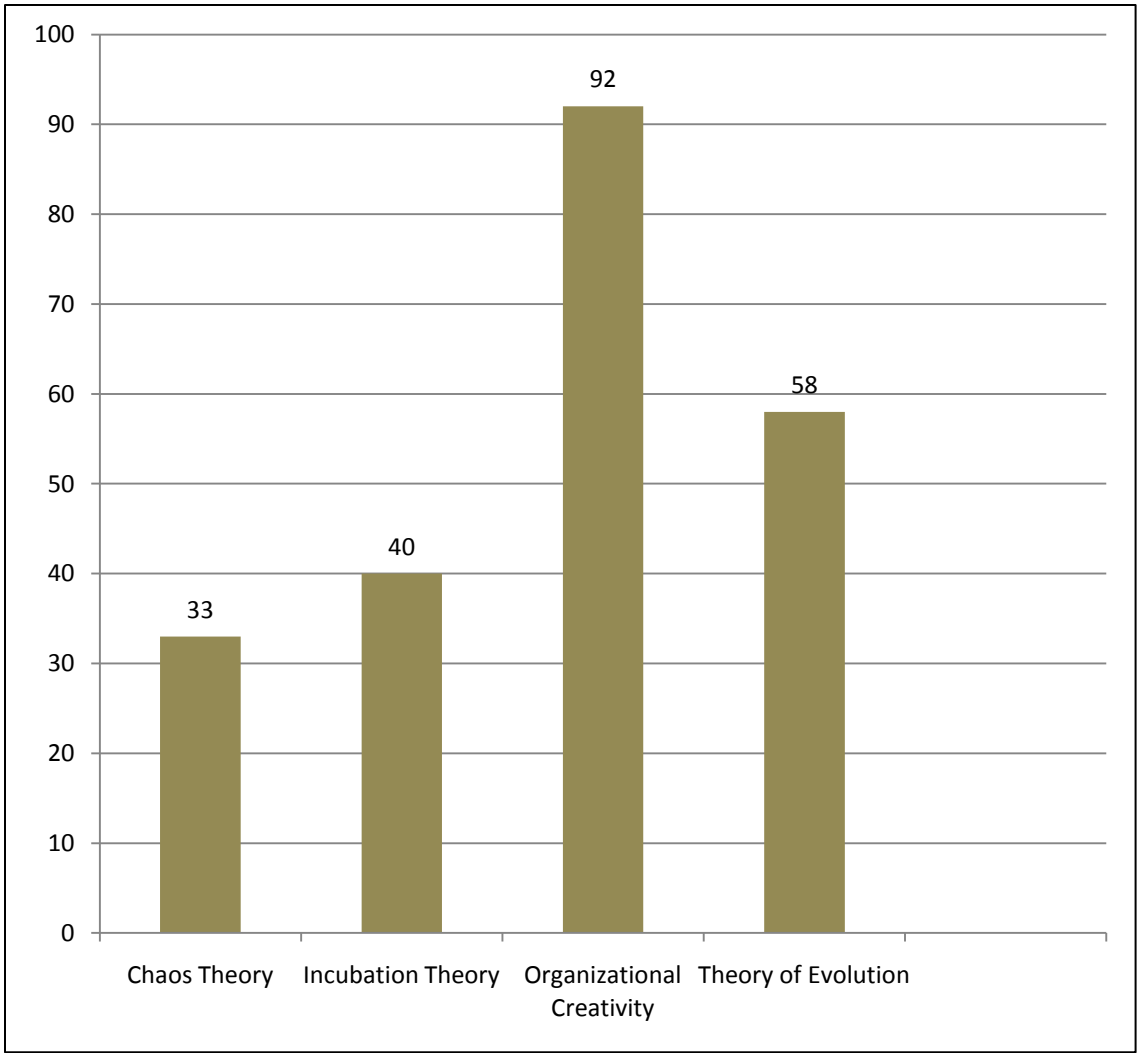

Figure 9 Perceptions of incubator alignment to change theory by cumulative votes of faculty (n=223)

Figure 10 below maps the cumulative votes on a spider chart showing the relative position of the magnitude of change theories as they were perceived by faculty. Concepts of organizational creativity are focused on dimensions in the environment which facilitate innovation and change. That approach differs from the grounded theory of incubation (Maital, Ravid, Seshadri, & Dumanis, 2008) because the details of the processes have not been identified for incubation. It is one thing to state that incubators shield ideas from forces in the environment that threaten viability, but another thing entirely to identify what those forces are and how they operate. Concepts of organizational creativity have the potential to inform incubation theory in that regard. Although it was surprising that Incubation Theory was not more widely recognized by faculty as central to activities of the incubator, these results are interpreted as supportive of the overall conceptual frame for this study. It is possible that the reason incubation processes were not more widely recognized as separate from concepts of organizational creativity is that they really are not different. Incubation has not been subjected to intense research on the details, dimensions, and contributing factors that support its processes. In order to fill that gap, research for this dissertation used concepts of organizational creativity as a tool for analysis. It is possible that further research will show the processes of incubation and organizational creativity are convergent and similar.

Further indication of the applicability of organizational creativity to the curriculum incubator was found in survey items. Items on the questionnaire relating to the personal

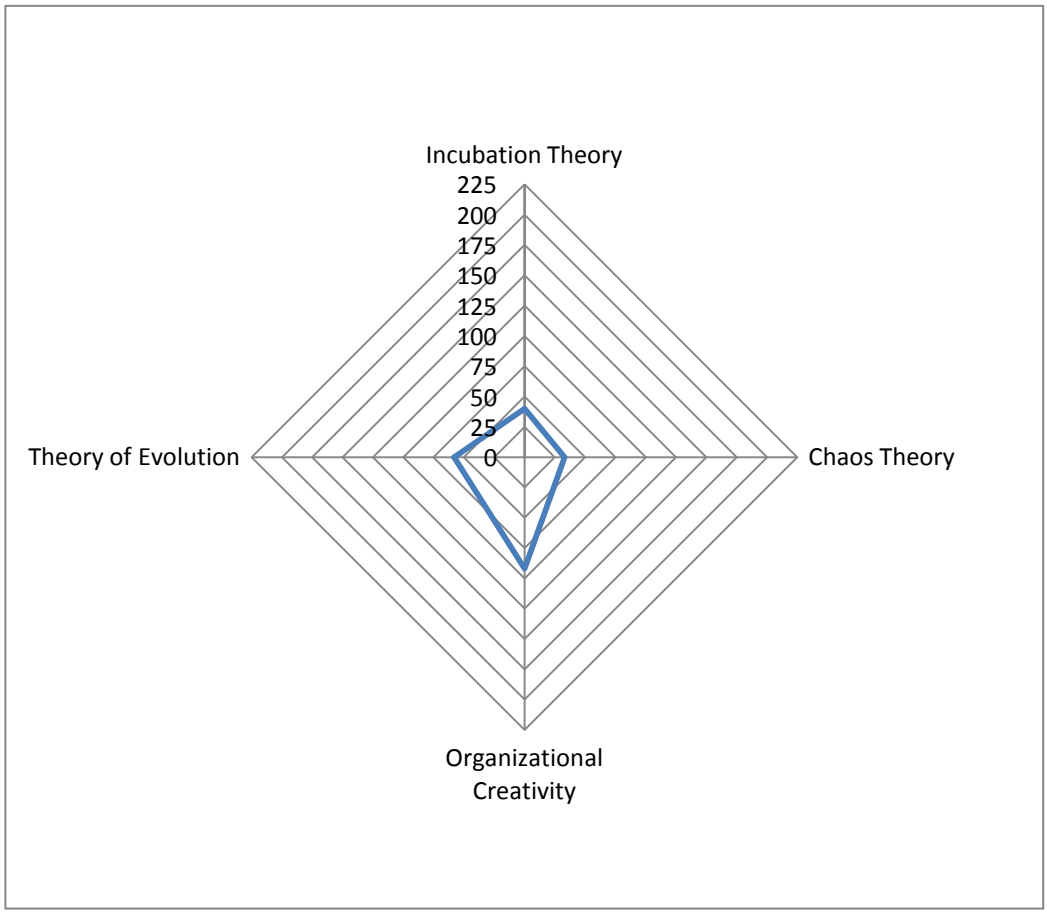

*Figure 10 R*elative alignments of cumulative vote patterns for descriptors of incubator change processes

importance of participation in the curriculum incubator were meant to discover what incubator participants observed as active operational processes. It was presumed that faculty would not find something personally important if it did not exist in the first place. Table 7 illustrates the mean for 9 dimensions of a creative organization as determined by the observations of faculty

Table 7

Rank of Mean Scores Indicating Alignment of 9-Dimensions of Organizational Creativity to the Curriculum Incubator (Scale 1-4)

Dimensions of Creativity	Mean	Standard Deviation
Playfulness/Humor	3.76	.44
Idea Support	3.68	.48
Risk-taking	3.59	.67
Trust & Openness	3.59	.73
Challenge/Involvement	3.50	.67
Conversations & Debate	3.50	.67
Idea Time	3.30	.77
Emotional Maturity	3.29	.85
Freedom to Pursue Interests	3.27	.63

who participated in the curriculum incubator. All dimensions had a theoretical range of 1 to 4 with a rating of 1 signifying the lowest and most unaligned score possible and 4 representing the highest and most aligned score possible. High scores indicate alignment to dimensions for organizational change. Figure 11 illustrates the same data but in a spider chart analysis showing the shape of data and the relative contribution of each dimension to the overall organizational environment.

Incubator processes were characterized as complex and creative, relying on processes that in some respects defied explanation. “I would describe the incubator as a concept as well as

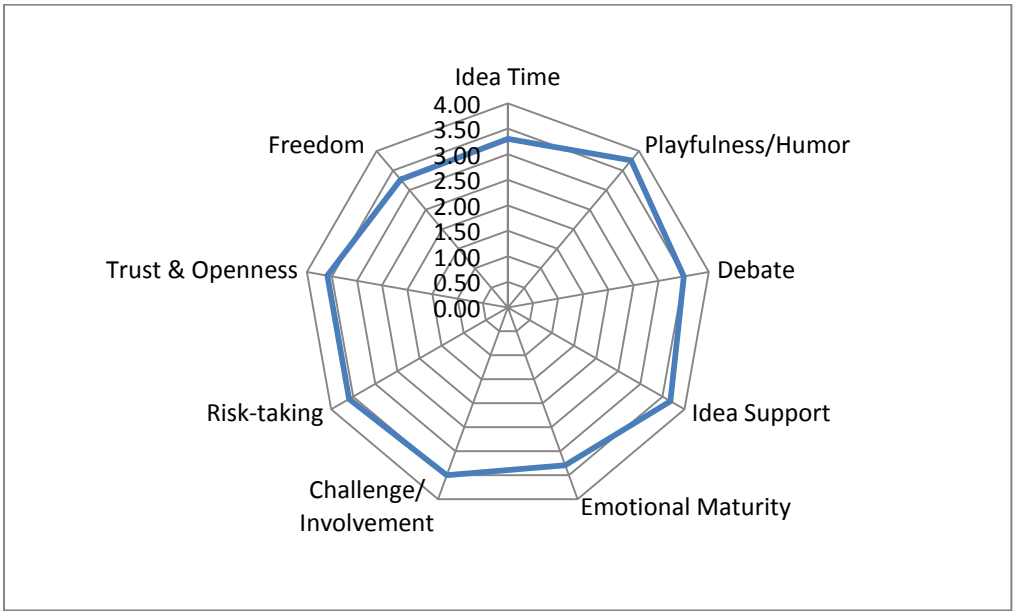

Figure 11 Scoring patterns of incubator alignment to organizational creativity as a process of change

a place that encourages and allows experimentation of courses." So, the incubator was both a space to experiment with curricular change and a mindset that willingly engaged in organizational change. The idea that the curriculum incubator aligned to creative processes of change was echoed in the interviews of faculty who were interviewed for this study. By developing a creative environment conducive to change, the curriculum incubator increased the probability that creative activities would occur. (Woodman, 2008). It was clear from interviews that a third element was equally important. Concepts of organizational creativity contributed to the general capacity to change and provided a base from which to implement the products of the creative environment.

> The curriculum incubator continues to innovate continues to change minds—continues to have outside partnerships; continues to impact the rest of the world. Continues to experiment and change engineering education in the country. It is

> a big job with lots of people that have to be coordinated. We do some research. There are multiple pieces and multiple elements. It is a big organizational change effort with lots of pieces. We keep experimenting and transitioning until someone else takes it over.

This quote demonstrates the alignment of the curriculum incubator with concepts of organizational creativity and change. Here, incubator change processes are viewed as a special kind of change a kind of intellectual problem solving that addresses the activities and the fundamental dynamics of the organization.

Support for alignment of incubator processes to organizational creativity change processes was strong enough that each dimension of the model was apparent in several interviews. Table 8 illustrates this point by summarizing each of the 9 dimensions of organizational creativity with a quote from faculty interviews along with the aggregate average score. Triangulating data from interviews and two sources in the questionnaire supported the model of incubation change processes as originating in creative change and less in concepts relating to incubation theory.

Table 8

Alignment of Incubator Change Processes to Organizational Creativity as Indicated in Interview Data

Dimension	Quote	Mean Score
Playfulness/ Humor	"One of the things we keep talking about is joy. We want to foster joy of engineering."	3.76
Idea Support	"We want to get the best ideas from anywhere…"	3.68
Risk-taking	'This is one of those times which I wish ambiguity were less. Sometimes it is really hard to plan when things are so unsettled.'	3.59
	"Any time you do something that is different, it becomes risky."	
Trust/Openness	"…an important part of the process is buy-in… making sure that people trust what we're doing is going to be okay."	3.59
Challenge/ Involvement	"there is sort of this magnetic attraction that when you have this innovative curricular stuff anyone who wants to do that will gravitate in your direction."	3.50
Debate	"..This is about changing the conversation and stimulating some reflection so that you get people to reflect on them a bit more."	3.50
Idea Time	"You start with fresh ideas. There're not very well thought out. You're giving them a change to emerge."	3.61
Emotional Maturity	'…developing a community spirit for engineering rather than being in competition, developing a more collaborative, cooperative view…"	3.29
Freedom to Pursue Interests	"The whole idea that we started with is choice and you cannot give up on that."	3.27

Research Question 3:
What Evidence is There That the Design of the Curriculum Incubator is Influencing Curricular Change?

Three kinds of evidence existed about incubator effectiveness: (a) beliefs, (b) activities, and (c) attitudes of faculty familiar with the incubator. Although faculty may not have fully understood how incubator processes contributed to organizational change, they did believe that the curriculum incubator influenced curriculum development. Interview data supported this finding. One faculty member expressed it this way:

> The model [for the curriculum incubator] came as we tried to explain to our selves what worked and why we thought it worked. We made a number of –you could say—informed choices. You could say guesses. You could say intuitive links. You could say a bunch of other things, but we made some reasonably good choices based on some pretty clear conceptual theoretical understanding of what we were trying to do. We didn't have a model at the front end. We have built this model as we tried to explain why did worked as well as it did.

The curriculum incubator was a small program, but interviews indicated that participants were committed and enthusiastic. In addition, participants were confident about the ability of their fellow faculty to make a meaningful contribution to curricular development. A key participant in the incubator put it this way:

> From day one I was convinced that [the curriculum incubator] had a future in this college. Given how creative my colleagues are, I was very optimistic about the fact that once we established it we developed a life of its own and different ideas and different opinions of how you will do that will help it mature to something much more – even much more creative than what [the original founders] first had in mind.

The fact that faculty observed the incubator taking on a life of its own was key evidence that incubator processes were working even if development was still in very early stages. The

incubator was developing a life of its own because people were attracted to it. The activities of the incubator were exciting and meaningful.

> There is a sort of magnetic attraction that when you have a place where innovation is happening. People who want to make a contribution will start to gravitate in that direction…the way the incubator is structured is to [provide]… that vision and that activity to grow out beyond that little group of vary dedicated people. We are looking for this group to leverage- to move the whole organization.

The faculty most likely to be interested and involved in incubator activities were those interested in teaching and the well-being of students. In a large research institution, these faculty are not plentiful. Reward systems and status encourage faculty to gravitate away from classroom interaction with students. Still, there was a small core of people whose background and personality incline them toward teaching and learning activities. Programs like the incubator offered focus, validation, and a refuge for faculty who often felt isolated from higher profile activities.

> I think, for me, my main aim is to have an impact on the students. But I have found, just personally, that the [curriculum incubator] has kind of given me a haven or a refuge where there are like-minded faculty, like-minded people, and that's been a real benefit for me. It's kinda given me, I think, more credibility.

Once faculty were involved, even on a very basic level, the freedom to explore and try new things was very fulfilling. One faculty member was developing a new course, something he had wanted to do for years. Until the incubator, his efforts had been discouraged leaving him frustrated and teaching the same old thing year after year.

> I think that the benefit of trying a few new things is to infuse sort of a new energy and a new enthusiasm, a new kind of a satisfaction in teaching. I mean, the pay-off there is huge -to simply unleash the creative outlet …The benefit for the faculty in having some kind of an incubator environment is that we feel like we're here on a higher mission when we feel like we can do some new things. So people are always talking about

> motivation and retention and keeping Illinois as the most excellent place, but the excellence is in this idea that we're doing new stuff.

Evidence from interviews of incubator effectiveness was powerful. Faculty believed in incubator concepts, participated in incubator activities, and their attitudes were committed and enthusiastic. But, interviews were tilted toward those faculty who were most active and presumably were most interested in incubator activities. Only survey data could provide documentation of a broader belief among participants that incubator activities were succeeding. Items on the questionnaire asked respondents to identify on a scale of 1 -4 the degree to which some activity was evidence that the incubator was influencing curricular change. When grouped together the 9 items relating to evidence for curricular change yielded a strong positive response from faculty. (M= 3.57/4.0) (SD=.34) p,.05.

All of the items corresponded to the 9 dimensions of organizational creativity. Scoring patterns indicate that faculty participating in the curriculum incubator believed there was strong evidence that the curriculum incubator influenced curricular development. Table 9 below identifies the items, the mean response per item and the standard deviation. On the scale, higher mean scores signified greater degrees of evidence for curricular change. In addition, an aggregate score for all 9 items in Section 3 of the questionnaire was calculated as an indicator of the overall perception of evidence that the curriculum incubator is influencing curriculum development. As a result of this calculation it was determined that faculty who participate in the curriculum i

Table 9

Summary of 9-Items Relating to Evidence for Curricular Change

Survey Item	Ekvall Category	Mean Response	Standard Deviation
New ideas for engineering education receive positive attention in iFoundry.	Idea Support	3.90	.30
iFoundry has created a flexible approach for exploring new ideas for engineering education.	Idea Time	3.68	.48
Faculty participants in iFoundry are committed to making curricular change succeed.	Challenge/ Involvement	3.67	.48
Faculty participants in iFoundry are gaining new insights about barriers to engineering education reform.	Emotional Maturity	3.62	.50
Faculty participants in iFoundry are enjoying the process of inquiry into issues of engineering education.	Playfulness/ Humor	3.60	.60
Because of iFoundry, testing of new ideas is possible even when outcomes are risky.	Risk-taking	3.55	.51
Faculty who participate in iFoundry are acquiring new information about engineering education.	Freedom to Pursue Interests	3.52	.68
Because of iFoundry, new opportunities exist for sharing knowledge about engineering education.	Conversation/ Debate	3.45	.67
Because of iFoundry, open discussions of engineering education are possible.	Trust/ Openness	3.35	.78

incubator found evidence that the incubator is positively influencing curricular change (*M* =3.57), (*SD*=.34), F(1,20)= 6.41, (p<.05). Figure 12 indicates the relative strength of

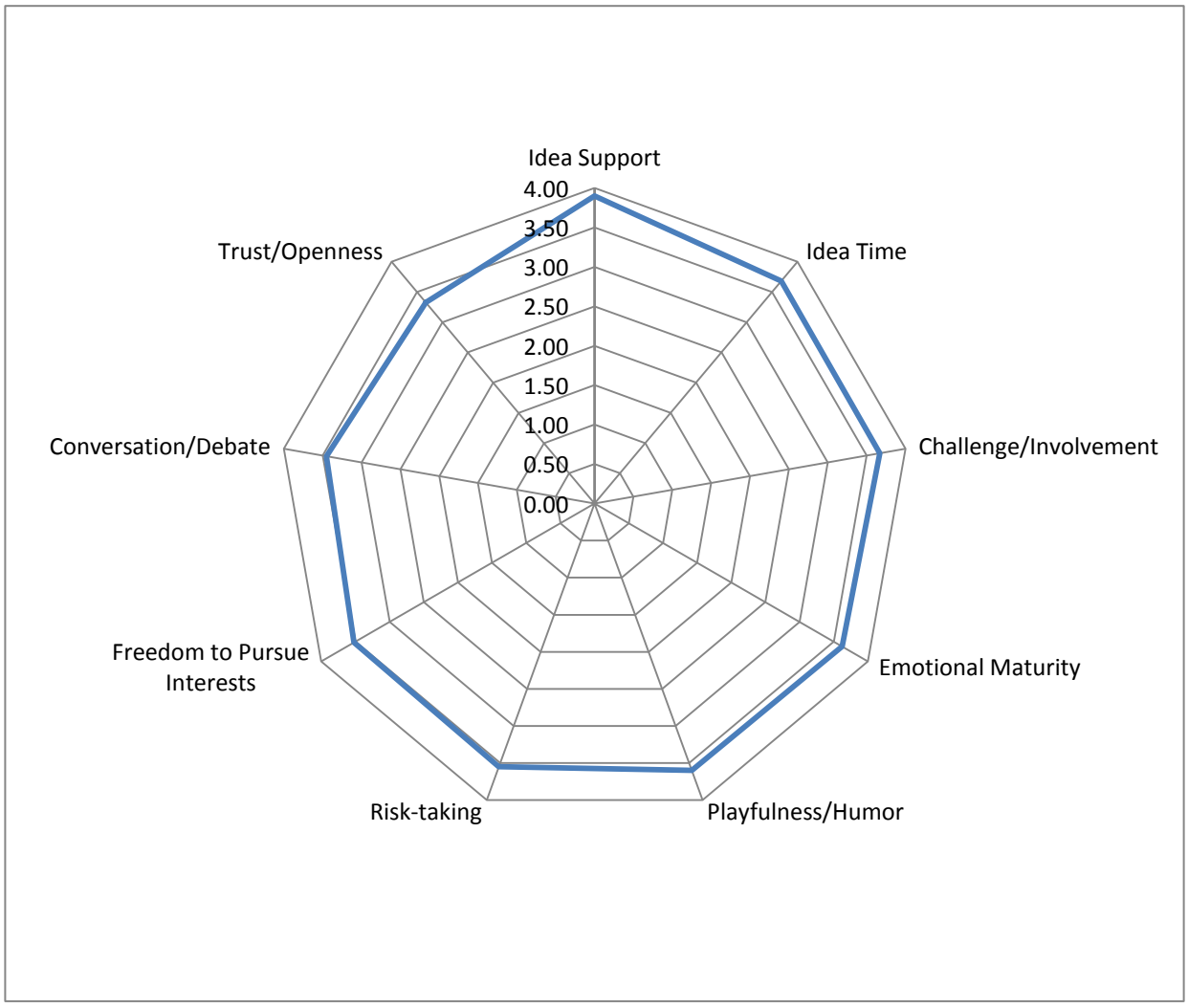

Figure 12 Patterns of evidence for change resulting from 9-dimensions of organizational creativity

the 9-dimensions on a spider chart. Scores indicate evidence of change based on the 9-dimensions of organizational creativity. The strength of these dimensions indicate readiness of for change (Isaksen, 2007a; Isaksen, 2007b). This readiness for change is based on a context characterized by a high presence of a collection of attributes consistent with a creative and innovative environment. Those attributes are measured in this dissertation by 9-dimensions of organizational creativity. As a check on the responses to sections 1-3 in the questionnaire the items are merged.

Merging the Data

As a last check on the perceptions of faculty respondents, sections 1-3 of the questionnaire were merged and an aggregate mean was calculated for each of the 9 dimensions of organizational creativity. The merged data indicates the overall strength of the 9-dimensions of organizational creativity in the curriculum incubator environment. By calculating the aggregated mean for each of the 9 dimensions, it was possible to get a fuller and more complete view of the attitudes, activities, and beliefs that characterized the curriculum incubator. The relatively greater strength of faculty attitudes, feelings, and beliefs in this study were consistent with an organizational environment ready and willing to make changes. An environment that is ready for change tends to result in enduring change (Isaksen, 2007b). The ranked summary of merged data is indicated in Table 10.

When these scores are plotted on a spider chart to illustrate relative magnitude the following diagram emerges. (See Figure 13) Scoring patterns indicate that faculty participating in the curriculum incubator held attitudes, beliefs, and engaged in activities that were strongly supportive of the curriculum incubator. These attitudes, beliefs, and actions were strong

Table 10

Ranked Summary of Merged Data from Sections 1-3 of the Faculty Questionnaire (Scale 1-4)

Ekvall (1996)/ Isaksen (2007) Dimensions	Mean	Standard Deviation
IDEA SUPPORT Openness to new ideas; exploration Of new ideas; diversity of perspectives	3.70	.30
IDEA TIME Opportunity to explore and develop new ideas; atmosphere of flexibility	3.68	.48
CHALLENGE/INVOLVEMENT Intrinsic motivation, commitment, joy, & meaningfulness	3.67	.48
EMOTIONAL MATURITY Psychological insight; emotional maturity	3.62	.50
PLAYFULNESS/HUMOR Atmosphere of spontaneity, light-heartedness	3.60	.50
RISK-TAKING Tolerance of uncertainty, ambiguity; willingness to gamble on new ideas	3.55	.51
FREEDOM Individual freedom to pursue interests	3.52	.68
DEBATE Sharing different experiences and knowledge	3.45	.67
TRUST/OPENNESS Trust, mutual respect & support	3.33	.80

evidence of the curriculum incubator's power to promote curricular development. Although faculty may not have fully understood how incubator processes overcame obstacles to curricular change, because their attitudes and beliefs were supportive of incubator processed, those attitudes, beliefs, and actions had the potential to result in positive curricular and organizational change. The strength of these attitudes, beliefs, and actions in and of themselves supported enduring and sustainable change both on the curricular and organizational levels.

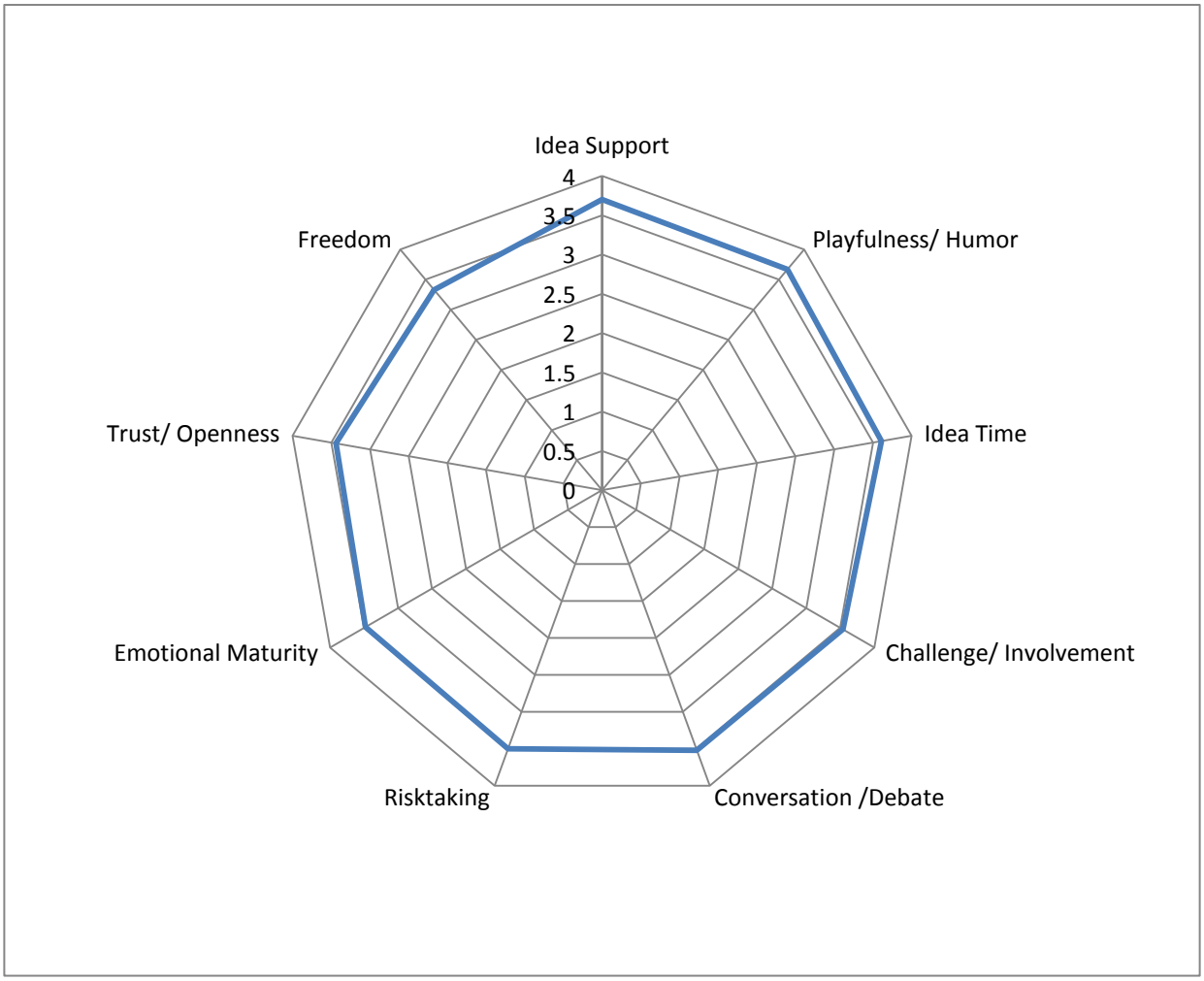

Figure 13 Merged data from sections 1-3 of the questionnaire

Comparing Profiles for Innovative Organizations. Although faculty seemed to believe that incubator activities were influencing curricular change, that didn't necessarily mean sustainable change was likely. As an additional check on evidence that the incubator was influencing change, the aggregate mean scores for the curriculum incubator needed to be compared to aggregate scores for other organizations which had established a track record of accepting or not accepting change.

Examples of scoring for other organizations were available from the work of Ekvall (1986; Isaksen, Lauer, Ekvall, & Britz, 2001). Ekvall's (1986) studies analyzed characteristics of organizational creativity using dimensions of organizational creativity. As a result of his work with organizations, Ekvall was able to calculate aggregate means along dimensions for organizational creativity that were parallel to the research conducted on the curriculum incubator. For his studies Ekvall used 10 organizations with a track record of innovation and compared them to 5 organizations with a record of stagnation or little change over a long period of time.

For his study Ekvall (1986) sorted companies based on criteria established by Nystrom & Edvardsson (1980). The following criteria were used: Innovative organizations invested in new products that increased the probability for their longer term survival. Stagnated organizations were unsuccessful in creating new products and experienced difficulties in their markets that marginalized their longer term viability. Once organizations were sorted the aggregated means of each type of organization were compared. In order to compare Ekvall's findings with the results of current research several hurdles needed to be overcome. The process for overcoming each of these hurdles is discussed below.

Three differences between the 1986 studies and the current dissertation project complicated the comparison of these data sets. The primary difference between those earlier studies and the current study is that Ekvall's 1986 research used the Creative Climate Questionnaire (CCQ). The CCQ was an early instrument developed by Ekvall (1983) and used to analyze organizations along 10 dimensions of organizational creativity. Later research by Ekvall and others replicated the earlier research but used only 9 dimensions of organizational creativity. The reason that later studies used only 9 dimensions is that research subsequent to Ekvall's (1983) studies indicated that issues of reliability and content validity justified a reduction from 10 to 9 items (Lauer, 1994). Based Lauer's (1994) work, a dimension, called dynamism, was omitted from future instruments and the newer instrument was named the Situational Outlook Questionnaire (SOQ). Both instruments have been reported to perform similarly and with consistent validity and reliability (Isaksen, Lauer, Ekvall, & Britz, 2001). Although the exact instruments were not used for this research, the CCQ and the revised and updated SOQ provided the conceptual foundation for this dissertation research and questionnaire. Items for the questionnaire were developed according to definitions and guidelines established for the SOQ (Ekvall, 1996; Ekvall & Ryhammar, 1999; Isaksen, Lauer, & ekvall, 1999; Isaksen, Lauer, & Ekvall, & Britz, 2001; Isaksen, 2007). For purposes of comparison in this study, the 1986 data is presented with the dimension of dynamism omitted.

Another difference between the earlier studies of organizations and the current research on the curriculum incubator involves the calculations Ekvall used to map the data from organizations. Although Ekvall's original studies and the current research both used 4-point Likert-style scales to assess organizational dimensions, Ekvall's (1986) 4-point scale ranged from 0-3. Ekvall first calculated aggregated averages for each dimension then converted the

means to scores on a spider chart as a way to provide a visual depiction of the patterns formed. As part of his mapping protocol Ekvall's aggregated averages were multiplied by 100 creating a score with a theoretical range of 0-300. Comparisons of scores involved mapping two sets of scores on a spider chart to compare the pattern differential between types of organizations.

The 4-point Likert-style scale used for this project ranged from 1-4. In order to overlay the results of Ekvall's research on the findings for the curriculum incubator the original 1986 scores were converted to a range of 100-400 by adding 100 points to each score. Then the aggregated averages for the curriculum incubator were converted to scores by multiplying the aggregated data by 100. This process converted all scores to a defined range of 100-400. This scoring profile allows for comparisons across dimensions.

The third issue with comparison of data between 1986 and the present involves the dimension of Emotional Maturity. Both the CCQ and SOQ utilize a dimension called Conflict. A low score on that dimension is a positive indication of an organization exhibiting characteristics representative of organizational creativity. The dimension of Conflict was originally defined: Presence of personal and emotional tensions in the organization. When the level of conflict is high, groups and individuals dislike and may even hate each other. The climate can be characterized by 'interpersonal warfare.' Plots, traps, power, and territorial struggles are usual elements of organizational life. Personal differences yield gossip and slander. In the opposite case, people behave in a more mature manner; they have psychological insight and control of impulses. People accept and deal effectively with diversity (Isaksen, Lauer, Ekvall, & Britz, 2001.)

For purposes of uniformity and simplicity, conflict was redefined to reflect a straightforward and more positive approach to organizational creativity. The definition adopted

for this dissertation is called Emotional Maturity and it is based on the reverse of the original definition: People behave in a mature manner; they have psychological insight and control of impulses. People accept and deal effectively with diversity. In order to make the aggregate score for conflict from the 1983 study comparable to the definition for Emotional Maturity used in the current research, a process was used to convert the score. The 1983 score for conflict in an innovative organization was 78. That score was converted to a positive score for emotional maturity by subtracting 78 from 300, the upper limit of Ekvall's score range. That difference is 222. Then, to convert the aggregated mean to a score ranging from 0-300 to a score ranging

Table 11 *Ekvall's CCQ Data Comparing Innovative and Stagnant Organizations**

	Innovative Organizations (n=10)			Stagnated Organizations (n=5)		
Dimension	M	SD	Range	M	SD	Range
Challenge/Involvement	238	27	219-300	163	10	154-176
Freedom	210	19	185-240	153	32	114-192
Trust/Openness	178	36	90-212	128	29	89-168
Idea Time	148	13	123-168	97	53	70-130
Playfulness/Humor	230	31	148-260	140	21	105-158
Emotional Maturity**	322	31	344-250	260	14	274-238
Idea Support	183	14	166-200	108	23	80-132
Conversation/Debate	158	31	110-204	105	6	98-112
Risk-taking	195	27	153-240	53	15	34-70

*From Isaksen, S. G., Lauer, K. J., Ekvall, G., & Britz, A. (2001). Perceptions of the best and worst climates for creativity: Preliminary validation evidence for the Situational Outlook Questionnaire. *Creativity Research Journal, 13*(2), 171-184, p. 178.
**Recalibrated from Conflict

from 1-400, 100 points were added. The final score for Emotional Maturity based on Ekvall's (1983) research is 322. The same process was followed for the Conflict dimension for stagnated organizations. The original data from Ekvall's (1986) study of organizational types is shown in Table 4.9 below.

Figure 14 compares the mean scores for the curriculum incubator to mean scores for 10 innovative organizations and 5 stagnant organizations. Organizations that exhibit high scores on organizational creativity scale have been shown to demonstrate an ability to support change, innovation, and creative problem solving (Isaksen, 2007). The resulting comparisons provide evidence that incubator activities are capable of fomenting an environment conducive to sustained change. Using an incubator as a change mechanism, one that creates a protected time and space for curricular research and experimentation, has the potential to encourage durable and sustainable curricular change. Other research has shown with a high degree of certainty that there is a strong relationship between the ability of an organization to implement new ideas and the perceptions of organizational members expressed as scoring of 9 dimensions of organizational creativity (Akkermans, Isaksen, & Isaksen, 2008).

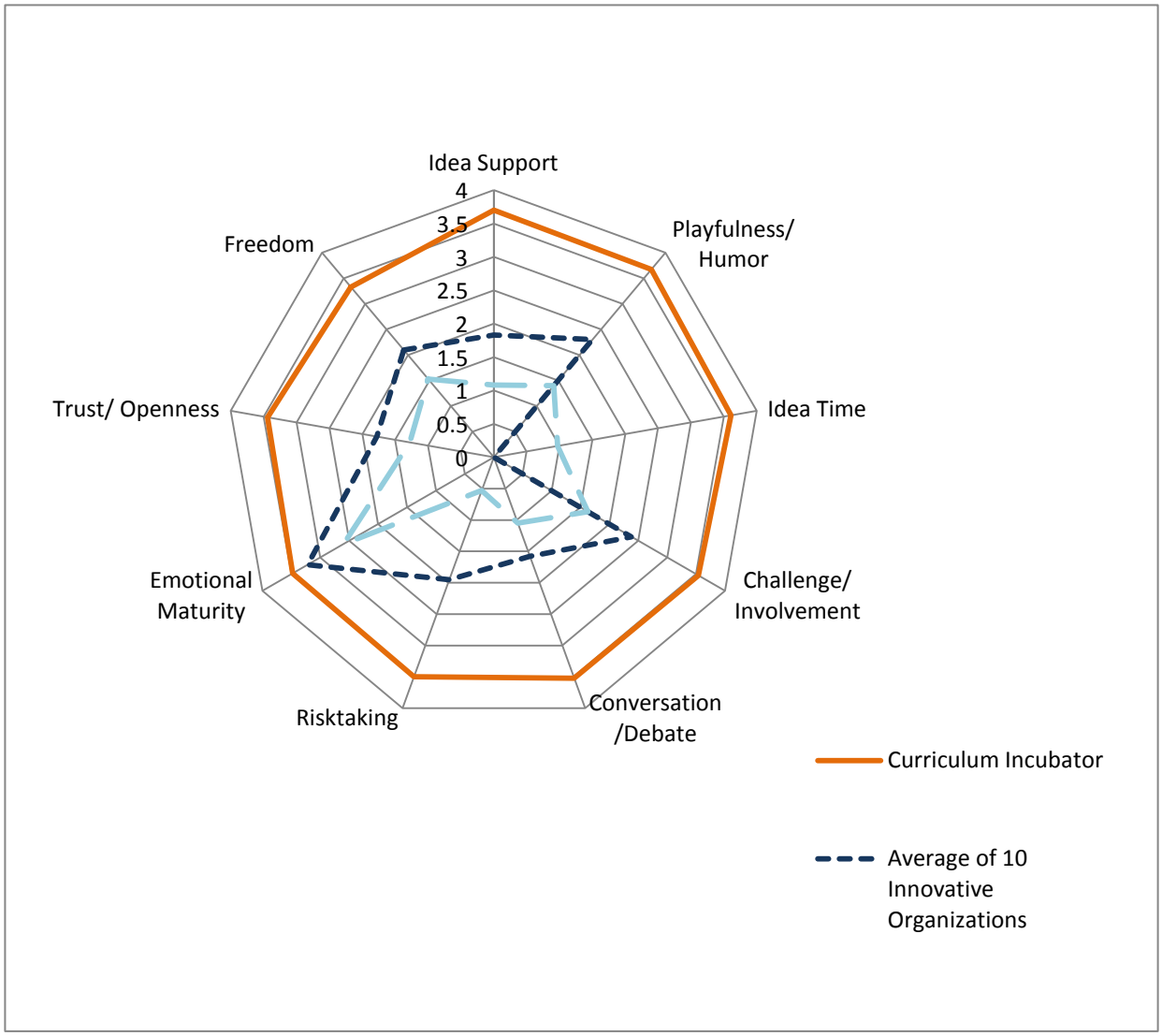

Figure 14 Comparative scores on 9-dimensions of organizational creativity among organizational types

Summary of Results

Findings of this study indicate that the curriculum incubator performs two parallel but related functions. Evidence of one function, curricular development, is highly visible in incubator activities that involve the proposing, exploring, and testing of new curricula. The other function is less visible but still echoed in the attitudes, beliefs, and actions, of faculty participants. Faculty participants who described the incubator did not mention things like size of office space, number of staff, frequency of meetings, or activities of the membership. The salient attributes were dimensional, philosophic and atmospheric. Attributes described factors of quality and excellence like collaboration, contribution, inclusiveness, exploration and experimentation. The incubator environment was idea-rich, accepting of experimentation, and reliant upon evidence for decision-making. Aggregated data included 20 attributes (p. 103) descriptive of curriculum incubator change processes. Together these attributes created a temporal space and psychological environment believed by participants to be conducive to change.

Although incubator processes focused on curricular change, they did not align well with traditional theories, formulas, or patterns of curricular change. The model was more of a reversal of the traditional planned change model relying instead on the collective wisdom and creativity of incubator participants to determine what students needed to know in order to succeed after graduation. Change processes were emergent and reliant upon 9 dimensions in the environment to promote effective and sustainable change. These dimensions were reflective of change processes in the theory of organizational creativity.

Evidence of incubator effectiveness was apparent in the beliefs, attitudes, and activities of incubator participants. Patterns of beliefs indicated strong agreement among participants that the incubator offered opportunity for change. As a check on faculty beliefs, aggregated data from

this study was compared to data from earlier studies relating to innovative and stagnated organizations. Findings from the incubator indicated that it compared favorably to other organizations with a track record for innovation and change.

Chapter V

Discussion

Based on the findings of this dissertation project three conclusions are possible.

- First, the salient attribute of the curriculum incubator appears to be the ability to nurture a temporal space and psychological environment in which organizational members are ready, willing, and able to create and sustain change.
- Second, the curriculum incubator is engaging in incubator practices by nurturing faculty ideas for curricular change. Proposed curricula are being tested on a small scale, refined, and retested on a larger scale. However, change processes align most closely to theoretical dimensions of organizational creativity.
- Third, evidence indicates the curriculum incubator has the potential to leverage sustainable curricular change through organizational change including the liberal application of four principles sited which resonated throughout the interviews and questionnaire: (a) voluntary participation and collaboration; (b) respectful, transparent and inclusive processes; (c) use of exploration and experimentation; and (d) evaluation and adaptation that embraced opportunity.

Findings of this study revealed a curriculum incubator characterized by thoughtfulness if not orderliness. Incubator processes focused on facilitating organizational change leaving curricular content in the hands of the stakeholders most willing to engage in the exploration and testing of alternatives. Incubator processes mimicked the surrounding academic environment relying heavily on research, collaboration, discovery, and learning. Participating faculty were

attracted to the curriculum incubator because they wanted an opportunity to find new ways to reach students and better prepare them for an unknown and changing future.

In reality, many typical organizational development processes were at work. Political dynamics played a role in the ability to change. There were consciousness raising, convincing, and mind changing activities. What distinguished the curriculum incubator was not that the usual forces of change swirled about the effort, but that the incubator minimized them opting instead to focus on creating an environment conducive to change. By relying on processes reminiscent of dimensions of organizational creativity, the incubator fostered a psychological **environment** characterized by a protective and nurturing temporal space in which opportunities could generate without the usual structural and organizational inhibitions. Second, an environment dominated by a creative frame of reference generates **opportunity.** In this case opportunity meant welcoming new ideas for curricular practices and testing them while minimizing the cost of failure. Third, individuals in the environment recognize opportunity and seize upon the **possibilities** that are created by it.

Understanding the potential for new possibilities bolstered optimism and supported effort. Fourth, the recognition of new possibilities facilitated **organizational innovation.** Lastly, innovation led to the discovery and implementation of **curricular change**. (See Figure 15) The most significant contribution of the curriculum incubator may lie less in the observable details of program activities and more in the emotional context of the contributory environment, less in curricular outcomes and more in attitudes, beliefs, and activities; less in plans or formulas and more in simple faith in human competence and the desire to make a meaningful contribution.

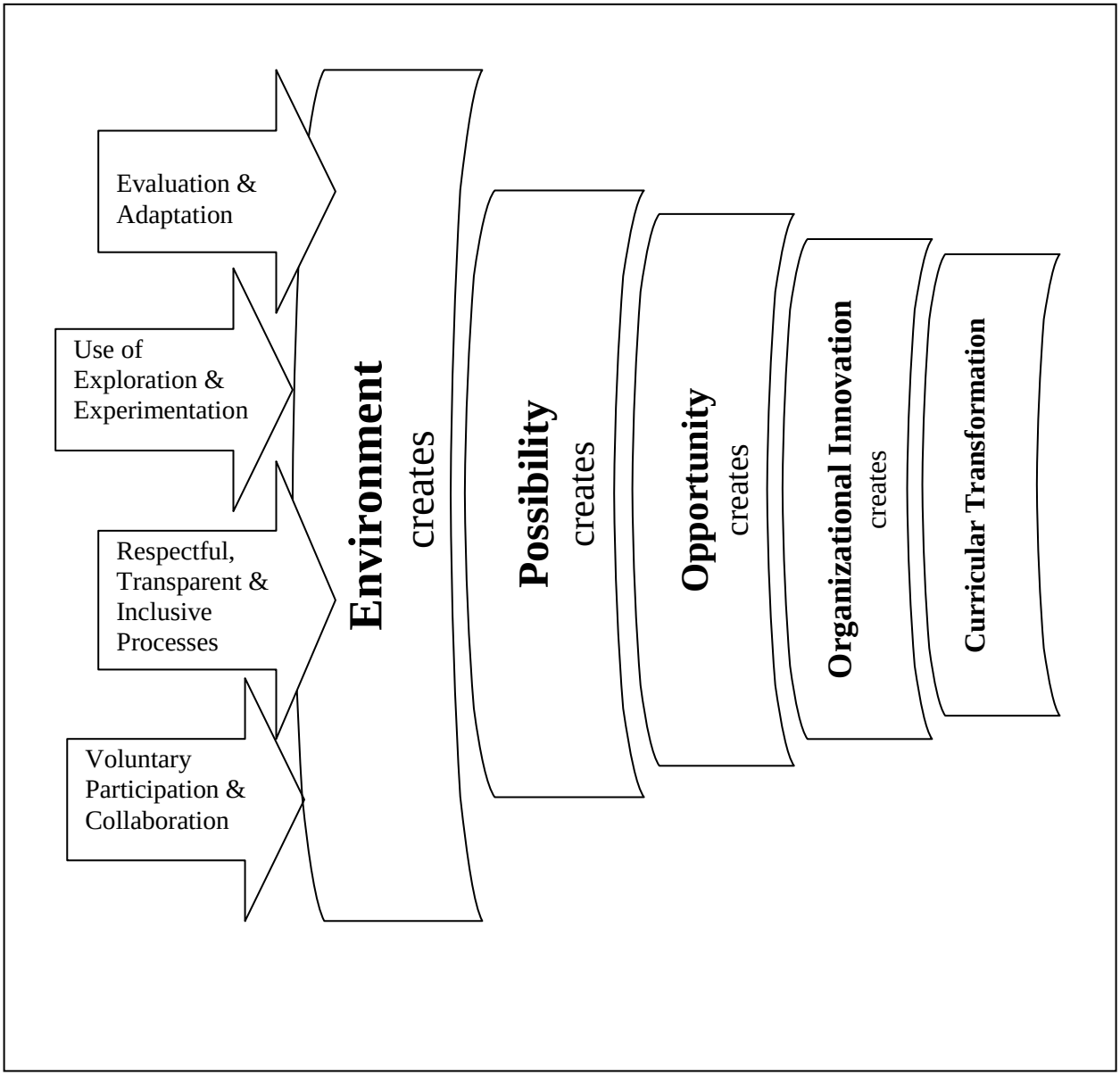

Figure 15 Processes of the curriculum incubator

Implications for Policy and Practice

If there are any implications to this study, they are about the way change happens and how it should be lead. Organizational change doesn't happen unless the individuals in the organization change too. That makes change, any change, tough. Traditional models for organizational change or, in the case of this dissertation, traditional models for planned curricular change, have been only marginally successful in assisting institutions. Traditional curricular change, orderly, linear change, often depends upon imposition, compliance, and top-down directives. Individuals with many points of view are expected to agree on the details of a change or a curricular plan. Agreeing on details requires willingness of people to see value in a perspective that is likely to be different from than their own and may not even be in their best interest. In imposed change environments that usually means acquiescence rather than enthusiastic endorsement. It is not human nature to enthusiastically endorse an idea based solely on logic or the appearance of merit. Imposed change creates stress, anxiety.

Enduring, sustainable change results from a positive emotional response, including the time and space in which to learn, understand, and accept a new point of view. Change involves letting go of comfortable attitudes, beliefs, and actions and replacing them with attitudes, beliefs, and actions that are unfamiliar even unsettling. A period of adjustment is required so that individuals can resettle, recapture a sense of self, and gain competency for living or working within new parameters. Given time, organizational members may be able to view change as offering exciting new opportunities.

Time and space need to be balanced by gentle hand of leadership. Leaders of change can create the temporal space and psychological environment for individual change. Leaders can make that space comfortable and reassuring. Leaders can listen, empathize, and respond in ways

that are not neat or tidy, but leadership must exist. Evaluation and assessment is a valuable tool to support direction and monitor change. Comfortable space in which to adapt can happen in a traditional planned curricular change effort or in any planned organizational change, but it won't happen without intent.

The curriculum incubator was able to suspend time and the typical demands of organizational participation so that members could think about change, begin to visualize a new way to function, and make the needed shifts in their attitudes, beliefs, and actions. This dissertation research found that environment to be most closely aligned to concepts of organizational creativity. Within the environment of the curriculum incubator, individuals had the freedom to chart their own course, to do what felt right at the most elemental level, and to adapt to change in a way that fulfilled their needs, made sense, and moved the organization forward.

The implications for policy are simple and not very different from recommendations in most textbooks. (a) Expect change to be messy and sporadic. (b) Start small. Begin with a group of people who have a vision for the future and willingness to connect broadly with others. (c) Keep the end in mind; keep the vision fresh, but forget about manipulating the details. (d) Maintain a human-centered approach; fulfill people's needs. (e) Gain momentum by being inclusive. Develop partnerships both inside and outside the institution. (f) Celebrate successes through speakers, discussions, workshops, or other programs. (g) Have faith in the human ability to create and adapt.

Limitations and Future Research

That said there are at least three limiting factors that must be underscored. The curriculum incubator was a specific case in one college at one institution and one point in time. Although I would argue that the broader implications for policy and practice are transferable, the exact configuration and sequence of organization and activities might not generalize to other places at different times. There are issues of strategy to consider that will differ from institution to institution.

Curricular change will be more effective if it occurs at a strategic location in the institution; one with the capacity to make broad connections to people and departments in ways that leverage institutional characteristics and strengths. The curriculum incubator was not a silo in spite of the fact that it may have appeared to be one. The incubator maintained permeable boundaries, made room for new participants, communicated broadly, and worked hard to avoid becoming isolated or elitist.

A second limitation is economic. Financial constraints could limit future efforts of the curriculum incubator. This dissertation focused on change. Neither budgetary issues nor curricular content and delivery were part of this research. However, two financial issues were observed as critical to the success of the curriculum incubator. The incubator sought to be creative and economically viable. Both incubator activities and the subsequent curricula that were developed needed to be cost-effective and efficient. Curricular change efforts avoided saddling departments with expensive changes that could cause hardships and not be practical or sustainable over the longer term.

To be viable and sustainable over the longer term, new curricula developed by the incubator had be realistic and accept practical limitations. Cost and scalability underscored

curricular research and development practices. Incubation activities recognized the necessity of finding lower cost higher quality ways to research and deliver curriculum. At the same time lower cost higher quality curricula tested on a small group of students had to be scalable. Curricular changes needed to be adaptable to large numbers of students with the same efficiency and high quality outcomes.

The last limitation involves leadership. The curriculum incubator benefited from having really talented leadership. Individuals associated with the incubator were contributing partners interested in the welfare of their department, college and institution. Efforts to replicate this example of a curriculum incubator are dependent upon leadership teams with diverse abilities and perspectives.

That said, this study was short term. Although evidence exists that the incubator was accomplishing change, only time will tell. The incubator was in formative stages of development at the time of this dissertation project. Testing and implementation of curricula were just beginning. In order to endure over time, curricular change must be sustainable, absorbed into the academic culture and become part of the regular sequence of teaching and learning activities. Knowledge about incubator processes would benefit from longer term study of curriculum development activities.

At least three additional suggestions for future research come to mind. (a) This research provides the basis for further exploration of incubation processes. Whether applied to business, curriculum development, or in any other context, incubation processes need to be deconstructed in order to better understand the practical and theoretical basis for their use. (b) There is room to further test concepts of organizational creativity as they apply to organizational change. Although an existing instrument was adapted for use in this dissertation project, in higher

education curricular change specifically and organizational change generally might benefit from development of contextually specific theory. Much remains to be learned about how positive sustainable change happens in college and university settings. (c) Theories such as those mentioned in this dissertation or others deserve consideration as models for curricular change. Although some literature exists on that topic, there is room to further explore and refine the applicability of alternate models for change and their benefit to higher education.

Models and theories for curricular change, or any change for that matter, are more helpful when they are simple and adaptable. The model for curricular change as analyzed and conceived by research in this dissertation project is simple in concept but complex in operation. Change happens when what is possible becomes what is. Complexity of the model lies in the messy, dynamic, non-linear, and anthropomorphic nature of change.

References

Abbey, A., & Dickson, J. W. (1983). R & D work climate and innovation in semiconductors. *Academy of Management Journal, 26*(2), 362-368.

Akkermans, H. J. L., Isaksen, S. G., & Isaksen, E. J. (2008). *Leadership for innovation: A global climate survey.* Orchard Park, NY: The Creative Problem Solving Group.

Alexander, F. K. (2000). The changing face of accountability. *The Journal of Higher Education, 71*(4), 411-431. Retrieved from http://www.jstor.org/stable/2649146

Allen, D. K., & Fitfield, N. (1999). Re-engineering change in higher education. *Information Research, 4*(3). Retrieved from http://informationr.net/ir/4-3/paper56.html

Allen, D. N., & McCluskey, R. (1990). Structure, policy, services, and performance in the business incubator industry. *Entrepreneurship Theory and Practice. 15*(2):61–77.

Amabile. T. M. (1988). A model of creativity and innovation in organizations. In B. M. Staw & L. L. Cummings (Eds.). *Research in organizational behavior,* 10, 123-167.

Amabile, T. M. (1996). *Creativity in context*. Boulder, CO: Westview Press.

Amabile, T. M. (1990). Within you, without you: Towards a social psychology of creativity and beyond. In M. A. Runco & R. S. Albert (Eds.) *Theories of creativity* (61-91). Newbury Park, CA: Sage Publications.

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal, 39,* 1154–1184.

Anderson, N. R., & West, M. A. (1998). Measuring climate for work group innovation: Development and validation of the team climate inventory. *Journal of Organizational Behavior, 19,* 235–258.

Andriopoulos, C. (2001). Determinants of organsational creativity: A literature review. *Management Decision, 39*(10), 834-840.

Argyris, C. (1991). Teaching smart people how to learn. *Harvard Business Review, 69*(3), 99-109.

Ashkanasy, N. M., Wilderom, C. P.M., and Peterson, M. F. (2000). *Handbook of Organizational Culture and Change*, Thousand Oaks, CA: Sage Publications.

Association of American Colleges. (1991). *The challenge of connecting learning: Liberal learning and the Art and Sciences major*. Retrieved from ERIC database (ED328137).

Association of American Colleges and Universities. (2002). *Greater expectations: A new vision for learning as a nation goes to college*. Washington DC.

Atkins, D. (2002). *A brief history of business incubation in the United States*. Athens, OH: National Business Incubation Association.

Aubin, D. (2009). Observatory mathematics in the nineteenth century. In E. Robson & J. Stedall (Eds.), *The Oxford handbook of the history of mathematics*. (pp. 273-298). Oxford, UK: Oxford University Press.

Ayers, D., Dahlstrom, R., & Skinner , S., (1997), Organizing for new product success: An empirical investigation of R&D marketing integration. *Journal of Marketing Research, 34*, 107-116.

Baldwin, C. K., Hutchinson, S. L., & Magnuson, D. R. (2004). Program Theory: A Framework for Theory-Driven Programming and Evaluation. *Therapeutic Recreation Journal, 38*(1), 16-21.

Barnett, R., & Choate, K. (2005). *Engaging the Curriculum in Higher Education*. New York, NY: Open University Press.

Bastedo, M. (2005). Curriculum in Higher Education. In R. O. Berdahl, P. G. Altbach, & P. Gumport (Eds.), *American Higher Education in the Twenty-First Century* (pp. 464-485). Baltimore, MD: The Johns Hopkins University Press.

Bergquist. W. H., Gould, R. A., and Greenberg, E. M. (1981). *Designing undergraduate education: A systematic guide*. San Francisco, CA: Jossey-Bass.

Bhabra-Remedios, R., & Lette, E. (2004). Business incubators: Fast tracking business success. *Businessdate, 12*(3), 6-8.

Biggs, J. (2001). The reflective institution: Assuring and enhancing the quality of teaching and learning. *Higher Education, 41*(3), 221-238.

Bok, D. (2007). *Our underachieving colleges: A candid look at how much students learn and why they should be learning more*. Princeton, NJ: Princeton University Press.

Boyer Commission on Educating Undergraduates in the Research University. (1998). *Reinventing undergraduate education: A blueprint for America's research universities.* [Online]. Available: http://naples.cc.sunysb.edu/Pres/boyer.nsf/

Brand, A. (1998). Knowledge management and innovation at 3M. *Journal of Knowledge Management, 2*(1), 17-23.

Bruner, J. (1960). *The process of education*. Cambridge, MA: Harvard University Press.

Cabra, J. F. (1996). *Examining the reliability and factor structure of the Climate for Innovation Questionnaire.* Unpublished master's thesis, State University College at Buffalo, NY.

Cameron, K. S., & Quinn, R. E. (2006). *Diagnosing and changing organizational culture*. San Francisco, CA: Jossey-Bass.

Campbell, C., Kendrick, R. C., & Samuelson, D. S. (1985). Stalking the latent entrepreneur: Business incubators and economic development. *Economic Development Review, 3*(2), 43-49.

Campbell, T., & Slaughter, S. (1999). Faculty and administrators attitudes toward potential conflicts of interest, commitment, and equity in university-industry relations. *Journal of Higher Education, 70*(3), 309-332.

Clandinin, D. J., & Connelly, F. M. (2000). Narrative inquiry: Experience and story in qualitative research. San Francisco, CA: Jossey-Bass.

Clark, B. (1987). *The academic life: Small worlds different words*. Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.

Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. *Administrative Science Quarterly, 17*(1), 1-25.

College of Engineering. (2007). *Whitepaper for an Illinois Foundry for Tech Vision and Leadership (IFoundry).* Retrieved January 15, 2008, from http://ifoundry.illinois.edu /blog/2009/03/25/files/2007/08/ifoundry_concept.pdf

Conrad, C. F., & Pratt, A. M. (1983). Making decisions about the curriculum. *Journal of Higher Education, 54,* 16-30.

Cooperrider, D. (1990) Positive image, positive action: The affirmative basis of organizing. In S. Srivasta & D. Cooperrider (Eds.), *Appreciative management and leadership: The power of positive thought and action in organizations.* San Francisco, CA: Jossey-Bass.

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle Creek, NJ: Pearson Education.

Creswell, J. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches.* Thousand Oaks, CA: Sage.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches (3rd ed.).* Los Angles, CA: Sage.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 209–240). Thousand Oaks, CA: Sage.

Cutright, M. (1997). *Planning in higher education.* Paper presented at the *Education Policy Research Conference*. Oxford, England. ERIC database. (ED 416741).

Daft, R.L. (1978). A Dual-core Model of Organizational Innovation. *Academy of Management Journal, 21*, 193-210.

Darwin, C. (1859). *On the origin of the species by means of natural selection*. London, United Kingdom: John Murray.

Denzin, N. K. (1978). *The research act: a theoretical introduction to sociological methods*. New York City, NY: McGraw-Hill.

Denzin, N. K., & Lincoln, Y. S. (2000).Introduction: The discipline and practice of qualitative research. In N. K. Denzen & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (1-28). Thousand Oaks, CA: Sage.

Denzin, N. K., & Lincoln, Y. S. (2008). Strategies of qualitative inquiry. Thousand Oaks, CA: Sage.

Dewey, J. (1938). *Experience and education*. New York City, NY: Collier Books.

Drazin, R., & Schoonhoven, C. B. (1996). Community, population, and organization effects on innovation: A multilevel perspective. *Academy of Management Journal, 39*(5), 1065-1083.

Dressel, P. L. 1968. *College and University Curriculum.* Berkeley, CA: McCutchan.

Dressel, P.L. (1980). *Improving degree programs: A guide to curriculum development, administration, and review.* San Francisco, CA: Jossey-Bass.

Dressel, P. L., & DeLisle, F. H. (1969). *Undergraduate curriculum trends.* Washington DC: American Council on Education.

Druckman, D., Singer, J. E., & Van Cott, H. (1997). *Enhancing organizational performance*. In National Research Council (Ed.). Washington DC: National Academy Press.

Duderstadt, J. (2008). Engineering for a changing world. *Millennium Project*, University of Michigan, Ann Arbor.

Duderstadt, J. J., & Womack, F. W. (2004). *The future of the public university in America: Beyond the crossroads.* Baltimore, Maryland: The Johns Hopkins University Press.

Eckel, P., Green, M. & Hill B. (2001). *Riding the waves of change: Insights from transforming institutions*. Washington DC: American Council of Education.

Eisner, E. W. (1991). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice*. New York City, NY: Macmillan Publishing Company.

Ekvall, G. (1967). *Industrial suggestion schemes.* Stockholm, Sweden: The Swedish Council for Personnel Administration.

Ekvall, G. (1971), *Creativity at the work place*, Stockholm, Sweden: Swedish Council for Personnel Administration.

Ekvall, G. (1983). *Climate, structure and innovativeness of organizations: A theoretical framework and an experiment.* Stockholm, Sweden: The Swedish Council for Management and Organizational Behavior.

Ekvall, G. (1986). *The current status of research on the creative climate questionnaire*. Buffalo, New York City, NY: Center for Studies in Creativity

Ekvall, G. (1987). The climate metaphor in organizational theory. In B. Bass & P. Drenth (Eds.) *Advances in organizational psychology.* Beverly Hills, CA: Sage.

Ekvall, G. (1991). The organizational culture of idea management: A creative climate for the management of ideas. In J. Henry & D. Walker (Eds.) *Managing Innovation* (pp. 73-79). London, UK: Sage.

Ekvall, G. (1996). Organizational climate for creativity and innovation. *European Journal of Work & Organizational Psychology, 5*, 105–124.

Ekvall, G. (1997). Organizational conditions and levels of creativity. *Creativity and Innovation Management, 6* (4), 195–205.

Ekvall, G., & Ryhammar, L. (1999). The creative climate: Its determinants and effects at a Swedish University. *Creativity Research Journal, 12*(4), 303-310.

Epstein, R. (1990). Generativity theory and creativity. In M. A. Runco &. R. S. Albert (Eds.), *Theories of Creativity*. Newbury Park, NJ: Sage Publications.

Finer, B., & Holberton, P. (2002). Incubators: There and back. *The Journal of Business Strategy, 23*(3), 23-25.

Fink, L. D. (2003). *Creating significant learning experiences for students*. San Francisco, CA: Josey-Bass.

Finney, J. W., & Moos, R. H. (1992). Four types of theory that can guide treatment evaluations. In H. Chen and P. H. Rossi (Eds.), *Using theory to improve program and policy evaluations* (pp. 15-27). Westport, CT: Greenwood Press.

Fischer, K. (2009, October 9). America falling: Longtime dominance in education Erodes. *The Chronicle of Higher Education*. Retrieved from http://chronicle.com/article/America-Falling-Longtime/48683/

Fisher, R. A. (1999). *The genetical theory of natural selection: A complete variorum edition*. In J. H Bennett (Ed.), New York, NY: Oxford University Press.

Flamholtz, E., & Randle, Y. (2009). *Leading strategic change*. New York, NY: Cambridge University Press.

Forest, S. (2008, October 2, 2008). Engineering's iFoundry looks at possible shift in curricula, teaching 'soft skills'. *Inside Illinois*. Retrieved from http://news.illinois.edu/ii/08/1002/biomedical.html#ifoundry

Frank, D. J., & Meyer, J. W. (2007). University expansion and the knowledge society. *Theory and Society, 36*, 287-311.

Freeland, R. M. (2001). Academic change and presidential leadership. In P. Altbach, P. J. Gumport, D. B. Johnstone (Eds.) *In defense of American higher education* (pp. 227-248). Baltimore, MD: Johns Hopkins University Press

Friedman, V. J. (2000). The incubator for social entrepreneurship: Creating partnerships for second order social change, *Annual Conference of the International Society for the Third-Sector Research,* Dublin, Ireland.

Fulmer, W. E. (2000). Shaping the adaptive organization: Landscapes, learning, and leadership in volatile times. New York city, NY: AMACOM

Futuyma, D. J. (2005). *Evolution.* Sunderland, MA: Sinauer Associates, Inc.

Gaff, J. G., Ratcliff, J. L. & Associates. (1997). *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices, and change*. San Francisco, CA: Jossey-Bass Publishers.

Gergen, K. J., & Gergen, M. M. (2000). Qualitative inquiry: Tensions and transformations. In N. Denzen & Y. Lincoln (Eds.) *Handbook of qualitative research 2nd ed.* (pp. 1025-1016). Thousand Oaks, CA: Sage.

Getz, M., & Siegfried, J. J. (1991). Costs and productivity in American colleges and universities. In C. T. Clotfelter, R. G. Ehrenberg, Getz, M., & J. J. Siegfried (Eds.), *Economic Challenges in Higher Education* (pp. 259-392). Chicago, IL: University of Chicago Press.

Gleick, J. (1987). *Chaos: Making a new science.* New York City: New York: Viking Press.

Gliem, J. A. & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's Alpha reliability coefficient for Likert-style scales. Proceedings from the 2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education. Columbus, OH: Ohio State University. Retrieved from https://scholarworks.iupui.edu/bitstream/handle/.../Gliem+&+Gliem.pdf?...1

Goetz, J. P., & LeCompt, M. D. (1984). *Ethnography and qualitative design in educational research*. San Diego, CA: Harcourt Brace Jovanovich.

Goldberg, D. E. (1994). *Change in engineering education: One myth, two Scenarios, and three foci*. Urbana, Il: University of Illinois.

Goldberg, D. E. (2006). *The entrepreneurial engineer*. Hoboken, NJ: Wiley-Interscience.

Goldberg, D. E. (2009). The missing basics & other philosophical reflections for the transformation of engineering education. In D. Grasso (Ed.), *The future of engineering education and practice*. Urbana, IL: University of Illinois.

Goldberg, D. E., & Cangellaris, A. (2008). *IFoundry and the creative engineer of the future*, Retrieved from http://www.ifoundry.illinois.edu/files/2008/09/ ifoundry-

Goldberg, D. E., & Loui, M. C. (2006). A white paper on engineering and technology studies at Illinois (ETSI). Urbana, IL: University of Illinois.

Grayson, L. P. (1993). *The making of an engineer: An illustrated history of engineering education in the United States and Canada*. New York City, NY: John Wiley & Sons, Inc.

Greene, J. C., Caracelli, V. J., and Graham, W.F. (1989). Toward a conceptual framework for mixed-method evaluation design. *Educational Evaluation and Policy Analysis, 11*(3), 255-74.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117).

Gumport, P. J. (1988). Curricula as signposts of cultural change. *Review of Higher Education, 12*(1), 49-61.

Gumport, P. J. (2000). Academic restructuring: Organizational change and institutional imperatives. *Higher Education, 39*, 67-91.

Hackett, S. M., & Dilts, D. M. (2004a). A real options-driven theory of business incubation. *Journal of Technology Transfer, 29*(1), 41-54.

Hackett, S. M., & Dilts, D. M. (2004b). A systematic review of business incubation research. *Journal of Technology Transfer, 29*(1), 55-82.

Hall, D. T., & Mirvis, P. H. (1996). The new protean career. In D. T. Hall (Ed.), *The Career is Dead-Long Live the Career: A Relational Approach to Careers*. San Francisco, CA: Jossey-Bass.

Halliburton, D. (1977). Designing curriculum. In A.W. Chickering, D. Halliburton, W. H. Berquist, & J. Lindquist (Eds.), *Developing the college curriculum* (pp. 51-74). Washington DC: Council for the Advancement of Small Colleges.

Hammond, S. A. (1996). *The thin book of appreciative inquiry.* Plano, TX: Thin Book Publishing Co.

Hammond, S. A., & Royal, C. (Eds.). (1998). *Lessons from the field: Applying appreciative inquiry.* Plano, TX: Practical Press Inc.

Hannon, P. D. (2004). A qualitative sense-making classification of business incubation environments. *Qualitative Market Research, 7*(4), 274- 283.

Hanson, W. E., Creswell, J. W., Plano Clark, V. L., Petska, K. S & Creswell, J. D. (2005). Mixed methods research designs in counseling psychology. *Journal of Counseling Psychology, 52*(2), 224-235.

Harwood, J. (2006) Engineering education between science and practice: rethinking the historiography. *History and Technology 22*(1): 53-79.

Harrison, R. T., Cooper, S. Y., & Mason, C. M. (2004). Entrepreneurial activity and the dynamics of technology-based cluster development: The case of Ottawa. *Urban Studies, 41*(5/6), 1045-1070.

Havelock, R.T. (1971). The utilization of educational research and development. *British Journal of Educational Technology, 2*(2), 84-98.

Hefferlin, J. B. L. (1969). *Dynamics of academic reform*. San Francisco, CA: Jossey-Bass.

Hilton, J. (2006) The future for higher education: Sunrise or perfect storm. *Educause Review 41,* 58-71

Horn, J. (2008). Human research and complexity theory. Educational Philosophy and Theory, 40(1), 130-143.

Holland, J. H. (1992). *Adaptation in natural and artificial systems*. Cambridge, MA: MIT Press.

House, C. H., & Price, R. L. (2009). *The HP phenomenon: Innovation and business transformation.* Stanford, CA: Stanford University Press.

Hrebiniak, L. G., & Joyce, W. F. (1985). Organizational adaptation: Strategic choice and environmental determinism. *Administrative Science Quarterly, 30*, 336-349.

Hughes, K. A. (2004). *Comparing pretesting methods: Cognitive interviews, respondent debriefing, and behavior coding* (U. S, Bureau of the Census Research Report Series #2004-02). Washington DC: Statistical Research Division.

Hunter, S. T., Bedell, K. E., & Mumford, M. D. (2007). Climate for creativity: A quantitative review. *Creativity Research Journal, 19*(1), 69-90.

Hutcheson, P.A. (1997) Structures and practices. In J. G. Gaff, J. L. Ratcliff, & Associates (Eds.), *Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, and practices, and change* (pp. 100-117). San Francisco, CA, Josey-Bass.

iFoundry. (n.d.) *iFoundry first class: Fall 2009.* Retrieved from http://ifoundry.illinois.edu/about/ Urbana, IL: University of Illinois.

iFoundry (2009). Illinois engineering freshman experience (iEFX). [website]. Retrieved from http://ifoundry.illinois.edu/admissions/

Ikenberry, S. O. (2001). Higher education and market forces. *USA Today, 129*(2670), 34.

Illinois Foundry for Innovation in Engineering Education. (n.d.). *About*, Retrieved August 15, 2009, from http://ifoundry.illinois.edu/about/

Isaksen, S. G. (2007a). The situational outlook questionnaire: Assessing the context for change. *Psychological Reports, 100*, 445-466.

Isaksen, S. C. (2007b). The climate for transformation: Lessons for leaders. *Creativity and Innovation Management, 16,* 1, 3-15.

Isaksen, S.G. and Ekvall, G. (2006) *Assessing your Context for Change: A Technical Manual for the Situational Outlook Questionnaire – Enhancing Performance of Organizations, Leaders and Teams*. Buffalo NY: The Creative Problem Solving Group.

Isaksen, S. G., & Kaufmann, G. (1990) Adaptors and innovators: Different perceptions of the psychological climate for creativity. In T. Rickards, P. Colemont, P. Grøholt, M. Parker, & H. Smeekes (Eds.), *Creativity and innovation: Learning from practice*. (pp. 47-54). Delft, The Netherlands: Innovation Consulting Group TNO.

Isaksen, S.G. and Lauer, K.J. (1999). The relationship between cognitive style and individual psychological climate: Reflections on a Previous study. *Studia Psychologica*, *41*, 177–91.

Isaksen, S.G. and Lauer, K.J. (2001). Convergent validity of the Situational Outlook Questionnaire: Discriminating levels of perceived support for creativity. *North American Journal of Psychology, 3*, 31–40.

Isaksen, S.G. and Lauer, K.J. (2002). The climate for creativity and change in teams. *Creativity and Innovation Management, 11,* 74–86.

Isaksen, S.G. and Tidd, J. (2006) *Meeting the Innovation Challenge: Leadership for Transformation and Growth*. Chichester, UK: Wiley.

Isaksen, S. G., Lauer, K. J., & Ekvall, G. (1999). Situational Outlook Questionnaire: A measure of the climate for creativity and change. *Psychological Reports, 85*, 665-674.

Isaksen, S. G., Lauer, K. J., Ekvall, G., & Britz, A. (2001). Perceptions of the best and worst climates for creativity: Preliminary validation evidence for the Situational Outlook Questionnaire. *Creativity Research Journal, 13*(2), 171-184.

Jones, S. R., Torres, V., & Arminio, J. (2006). *Negotiating the complexities of qualitative research in higher education: Fundamental elements and issues.* New York City, NY: Routledge.

Kantor, R. M. (1985). Managing the human side of change. *Management Review, 74*(4), 52-56.

Kay, R. (1989). Managing creativity in science and high tech. New York City, NY: Springer-Verlag.

Katz, J. (2008). Talent incubators. *Industry Week, 257*(8), 14-16.

Kember, D., & Leung, D. Y. (2005). Changing the learning environment to enhance students' metacognition in Hong Kong primary school classrooms. *Learning Environments Research, 8*(3), 221-243.

Kerr, C. (1963). *The uses of the university*. Cambridge, MA: Harvard University Press.

Kezar, A. (2001). Understanding and facilitating organizational change in the 21st century: Recent research and conceptualizations. *ASHE-ERIC Higher Education Reports, 28*(4), 1-147.

Kilman, R. M., & Johnson, N. A. (2005). What every undergraduate should know about evolution (and why). *BioScience, 55*(11), 926-927.

Kinni, T. (2003, September 22). The art of appreciative inquiry. *Harvard Business School Working Knowledge.* Retrieved from http://hbswk.hbs.edu/archive/3684.html

Kirsch, I., Braun, H., Yamamoto, K., & Sum, A. ((2007). *America's perfect storm: Three forces changing our nation's future*. Princeton, N.J: Educational Testing Service. Retrieved from www.ets.org

Kluver, J. D. (2004). Disguising social change: The role of nonprofit organizations as protective masks for citizen participation. *Administrative Theory & Praxis, 26*(3), 309-324.

Kotter, J. P. (2007). Leading change: Why transformation efforts fail. *Harvard Business Review, 85*(1), 96-103.

Krathwohl, D. R. (1998). *Methods of Educational and Social Science Research: An Integrated Approach, 2nd Edition*. Long Grove, Il: Waveland Press, Inc.

Kupperschmidt, B. R., & Burns, P. (1997). Curriculum revision isn't just change: It's transition. *Journal of Professional Nursing, 13*(2), 90-98.

Lattuca, L. R., & Stark, J. S. (2009). *Shaping the college curriculum*. San Francisco, CA: Jossey-Bass.

Lauer, K. J. (1994) The assessment of creative climate: An investigation of Ekvall's Creative Climate Questionnaire. Unpublished master's thesis, State University College at Buffalo, New York.

Lesk, M. (1997). How much information is there in the world? *Technical Report,* Rutgers University, Camden, NJ.

Levine, A. (1978). *Handbook of the undergraduate curriculum: A report for the Carnegie Council on Policy Studies in Higher Education.* San Francisco, CA: Josey-Bass.

Lewis, D. A. (2001). Does technology incubation work? A critical review of the evidence. U. S. Department of Commerce Economic Development Administration, Washington DC. Retrieved from www.eda.gov/

Lincoln, Y. S. (1986). A future-oriented comment on the state of the profession. *The Review of Higher Education, 10*(2), 135-142.

Lindquist, J. (1978). *Strategies for change*. Berkley, CA: Pacific Soundings Press.

Loui, M. C. (2007). Moments of inertia: toward an agenda for sociological research on why engineering professors resist changes in pedagogy and curriculum, . In R. Spalter-Roth, & B. Lovitts (EdS.), *The acceptance and diffusion of innovation: A cross-disciplinary approach to instructional and curricular change in engineering* (pp. 71-77). Washington, D.C: American Sociological Association.

Lorenz, E. N. (1963). Deterministic nonperiodic flow. *Journal of the Atmospheric Sciences 20,* 130–141.

Lukacs, J. (1961). *A history of the Cold War.* Garden City, New York City, NY: Doubleday & Company.

Lyman, P., & Varian, H. (2000). How much information? *The Journal of Electronic Publishing, 6*(2). Retrieved from http://quod.lib.umich.edu/cgi/t/text/text-idx?c=jep;view=text;rgn=main;idno=3336451.0006.204

Maital, S., Ravid, S., Seshadri, D. V. R., & Dumanis, A. (2008a). Toward a grounded theory of effective business incubation. *Vikalpa: Journal for Decision Makers, 33*(4), 1-13.

Maital, S., Ravid, S., Seshadri, D. V. R., & Dumanis, A. (2008b). *Critical success factors for entrepreneurial projects within incubators: A comparative study of Israel and India.* Retrieved from http://www.neaman.org.il/Neaman/publications/publication_item.asp?fid=770&parent_fid=488&iid=3914

Major, D. A. (2000). Effective newcomer socialization into high-performance organizational cultures. In N. M. Ashkanasy, C. P. M. Wilderom, & M. F. Peterson (Eds.), *Handbook of organizational Culture & climate*. (pp. 355-368). Thousand Oaks, CA: Sage.

March, J. G., & Olsen, J. P. (1976). *Ambiguity and choice in organizations*. Bergen, Norway: Universitetsforlaget.

Masland, A. T. (1985). Organizational culture in the study of higher education. *The Review of Higher Education, 8*(2), 157-168.

Merton, P., Clark, C., Richardson, J., & Froyd, J. (2001). Engineering curricular change across the foundation coalition: Potential lesions from qualitative research. Symposium conducted at the 31st ASEE/IEEE Frontiers in Education conference, Reno, NV. Retrieved from citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.16.4752&rep...

Merton, P., Froyd, J. E., Clark, M. C., & Richardson, J. (2009). A case study of relationships between organizational culture and curricular change in engineering education. *Innovative Higher Education, 34*(4), 219-233.

Mian, S. A. (1997). Assessing and managing the university technology business incubator: An integrative framework. *Journal of Business Venturing*, *12*(4), 251-285.

Miles M., and Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook.* Thousand Oaks, CA: Sage.

Morgan, G. (1986). *Images of'organization.* Newbury Park, CA: Sage.

O'Connor, J. J., & Robertson, E. F. (2003). *History of Mathematics -Poincare*. [website] Retrieved from http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Poincare.html

National Business Incubator Association. (n.d.). Retrieved from http://www.nbia.org/

Nelson, G. C. (1996). The information technology revolution and higher education. *Journal of Agribusiness, 14*(2), 221-232.

News. (2009, June 22). iFoundry receives HP Innovation in Education Award. [web post]. Retrieved from http://ifoundry.illinois.edu/press/

Nordvall, R. C. (1982). *The process of change in higher education*. (Research Report No. 7). Washington, DC: American Association for Higher Education. Retrieved from ERIC database. (ED225472).

O'Connor, J. J., & Robertson, E. F. (2003). *History of Mathematics -Poincare*. Retrieved July 14, 2010, from http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Poincare.html

OIP (2008, September 12). *A memorandum of understanding between Franklin W. Olin College of engineering and the university of Illinois at Urbana-Champaign.* Unpublished document. College of engineering, University of Illinois at Urbana-Champaign, Illinois.

Oldham, G. R., & Cummings, A. (1996). Employee creativity: Personal and contextual factors at work. *Academy of Management Journal, 39,* 607–634.

O'Meara, K. (2005). Encouraging multiple forms of scholarship in faculty reward systems: Influence on faculty work-life. *Planning for Higher Education, 34*(2), 43-53.

Opstal, D. V., Evans, C., Bates, B., & Knuckler, J. (2007) Thrive: The skills imperative. Washington, DC: Council on Competitiveness.

Patton, M. Q. (1990). *Qualitative evaluation and research methods (2nd ed.).* Newbury Park: Sage.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, California, Sage Publications.

Patton, M. Q. (2008). *Utilization-focused evaluation* (4th ed.) Newbury Park, CA: Sage Publications.

Preskill, H., & Torres, R. T. (1999). *Evaluative inquiry for learning in organizations*. Thousand Oaks, CA: Sage Publications.

Presser, J., and Blair, J. (1994). Survey pretesting: Do different methods produce different results?, in P.V.Marsden (ed.), *Sociological methodology, Vol. 24*, (pp. 73-104). Washington, DC: American Sociological Association.

Quinn, R., & Spreitzer, G. (1991).The psychometrics of the competing values culture instrument and an analysis of the impact of organizational culture on quality of life. *Research in Organizational Change and Development, 5,* 115-142.

Ratcliff, J. L. (1997). What is a curriculum and what should it be? In J. G, Gaff, J. L. Ratcliff, and Associates (Eds.), *Handbook of the undergraduate curriculum: A comprehensive guide to purposes and structures, practices, and change* (pp. 5-29). San Francisco, CA: Josey-Bass.

Reilly, D. H. (2000). Linear or nonlinear? A metacognitive analysis of educational assumptions and reform. *The International Journal of Educational Management, 14*(1), 1-7.

Richardson, J. (2005). Ancient insights into the modern organization. In K. Richardson (Ed.), *Managing organizational complexity: Philosophy, theory and application* (pp. 345-360). Charlottesville, NC: Information Age publishing.

Roy, D., Borin, P., & Kustra, E. (2007). Assisting curriculum change through departmental initiatives. *New Directions for Teaching and Learning, 112*, 21-32.

Rudolph, F. (1962). *The American college and university: A history*. New York: Vintage Books.

Runco, M. A. (2007). *Creativity: Theories and themes: Research and practice*. Boston, MA: Elsevier.

Ryhammar, L., & Smith, G. J. W. (1999). Creative and other personality functions as defined by perdept-genetic techniques and their relation to organizational conditions. *Creativity Research Journal, 12*(4), 277-286.

Schein, E. H. (1990). Organizational culture. *American Psychologist, 45*, 109-119.

Schein, E. H. (2004). *Organizational culture and leadership* (3rd ed.). San Francisco, CA: Jossey-Bass.

Scott, G. (2003, November-December). Change management in higher education. *Educause Review*, 64-80.

Senge, P.M. (1990) *The fifth discipline: The art and practice of the learning organization.* New York City, NY: Doubleday.

Sethi, R., & Nicholson, C. Y. (2001). Structural and contextual correlates of charged behavior in product development teams. *The Journal of Product Innovation Management, 18,* 154–168.

Shalley, C. E., & Zhou, J. (Ed.). (2008). *Organizational creativity research: A historical overview*. New York City, NY: Lawrence Erlbaum Associates.

Shields, P. M., & Hassan, T. (2006). Intermediate theory: The missing link to successful student scholarship. *Journal of Public Affiars in Education, 12*(3), 313-334. Retrieved from http://ecommons.txstate.edu/polsfacp/39/

Slaughter, S. & Leslie, L. (1997). *Academic capitalism: Politics, policies and the entrepreneurial university.* Baltimore, MD: Johns Hopkins University Press.

Smyth, R. (2004). Exploring the usefulness of a conceptual framework as a research tool: A researcher's reflections. *Issues in Educational Research, 14*(2), 167-180.

Spalter-Roth, R., Fortenberry, N., and Lovitts, B. (2007). *The acceptance and diffusion of innovation: A cross-disciplinary approach to instructional and curricular change in engineering.* Washington, D.C.: American Sociological Association.

Staggs, S. L., White, M. L., Schewe, P. A., Davis, E. B., Dill, E. M. (2007). Changing systems by changing individuals: The incubation approach to systems change. *American Journal of Community Psychology, 39*(3-4), 365-379.

Stark, J. S., Briggs, C. L., Rowland-Poplawski, J. (2002). Curriculum leadership roles of chairpersons in continuously planning departments. *Research in Higher Education, 43*(3), 329-356.

Strauss, G. (1998). An overview. In F. Heller, E. Pusic, G. Strauss, and B. Wilpert, B. (Eds), *Organizational Participation: Myth and Reality* (pp. 8-39). Oxford, United Kingdom: Oxford University Press.

Stenhouse, L. (1975). *An introduction to curriculum research and development*. London. UK: Heinemann.

Taleb, N. N. (2010). The black swan: The impact of the highly improbable. New City, NY: Random House.

Talbot, R., Cooper, C., & Barrow, S. (1992). Creativity and stress. *Creativity and Innovation Management, 1*, 183 - 193.

Tashakkori, A. & Teddlie, C. (2003). *Handbook of Mixed Methods in Social & Behavioral Research*. Thousand Oaks, CA: Sage.

Tesluk, P. E., Farr, J. L., & Klein, S. R. (1997). Influences of organizational culture and climate on individual creativity. *Journal of Creative Behavior, 31,* 27–41.

Thamhain, H. J. (2003). Managing innovative R&D teams. *R&D Management, 33,* 297–311. Retrieved from www.carnegiefoundation.org/

The Carnegie Foundation. (n.d.). The Carnegie classification of institutions of higher education. [website]. Retrieved from http://classifications.carnegiefoundation.org/

Thelen, E. (1989). self-organization in developmental processes: Can systems approaches work? In M. Gunnar & E. Thelen (Eds.), *Systems and development: The Minnesota Symposium in Child Psychology, 22* (pp. 77-117). Hillsdale, NJ: Lawrence Erlbaum Associates.

Thelin, J. R. (2004). *A history of American higher education*. Baltimore, MD: The Johns Hopkins University Press.

Thompson, R. (2009). Creativity, knowledge and curriculum in further education. *British Journal of Educational Studies, 57*(1), 37-54.

Tight, M. (2004). Research into higher education: an a-theoretical community of practice? *Higher Education Research and Development, 23*(4), 395-411.

Toombs, W., & Tierney, W. G. (1991). *Meeting the mandate: Renewing the college and departmental curriculum.* Washington, DC: George Washington University.

Tourangeau, R., Rips, L. J., & Rasinski, K. (2000). *The psychology of survey response*. Cambridge, UK: Cambridge University Press.

Trice, H. M., & Beyer, J. M. (1993). *The cultures of work organizations.* Englewood Cliffs, New Jersey: Prentice Hall.

Twigg, C. A. (2005). *Policy alert: Course redesign improves learning and reduces cost*. San Jose, CA: The National Center for Public Policy and Higher Education.

Trowler, P. (1998). *Academic responding to change: New hgher education frameworks and academic Cultures*. Philadelphia, PA: Open University Press.

Trowler, P. (2008). *Universities into the 21st Century: Cultures and Change in Higher Education: Theories and Practice*. New York, NY: Palgrave Macmillan.

Trump, M. A. (1998). *What is chaos? A five part online course for everyone*. Retrieved from the Ilya Prigogine Center for Studies in Statistical Mechanics and Complex systems at the University of Texas at Austin website: http://order.ph.utexas.edu/chaos/

Turnipseed, D. (1994). The relationship between the social environment of organizations and the climate for innovation and creativity. *Creativity and Innovation Management, 3,* 184- 195.

U.S. Department of Education. (2006) *A Test of Leadership: Charting the Future of U.S. Higher Education.* Washington, DC: Spellings Commission.

U. S. Department of Education. (2008). A national accountable: Twenty-five years After a Nation at Risk. Washington DC: Boyer Commission.

Waldrop, M. M. (1992). *Complexity: The emerging science at the edge.* New York city, NY: Simon & Schuster.

Weick, K.E. (1979). Cognitive processes in organization. In B.M. Staw (Ed.), *Research in organizational behavior*. *Vol. 1,* (pp. 41-74). Greenwich, CT: JAI Press.

West, M. A., & Richter, A. W. (2008). Climates and cultures for innovation and creativity at work. In J. S. Zhou, C. E. (Ed.), *Handbook of Organizational Creativity*. New York City, NY: Lawrence Erlbaum Associates.

Wheatley, M. J. (1999). *Leadership and the new science: Discovering order in a chaotic world*. San Francisco, CA: Berrett-Koehler Publishers.

Williams, W. M., & Yang, L. T. (Ed.). (2009). *Organizational creativity*. In R. J.Sternberg (Ed.). Handbook of creativity (pp. 373-391). New York City, NY: Cambridge University Press.

Willis, G., Schechter, S., & Whitaker, K. (1999). A comparison of cognitive interviewing, expert review, and behavior coding: What do they tell us? *Proceedings from the Annual Meeting of the American Statistical Association*. Alexandria, VA: American Statistical Association.

Woodman, R. W. (2008). Creativity and organizational change: Linking ideas and Extending. In J. Zhou & C. E. Shalley (Eds.). *Handbook of organizational creativity theory* (pp. 283-300). New York City, NY: Lawrence Erlbaum Associates.

Woodman, R. W., Sawyer, J. E., & Griffin, R. W. (1993). Toward a theory of organizational creativity. *Academcy of Management Review, 18*(2), 293-321.

Yin, R. K. (1994). *Case study research, design and methods, 2nd ed*. Thousand Oaks, CA: Sage Publications.

Yin, R. K. (2003). *Case study research, design and methods, 3rd ed*. Newbury Park, NJ: Sage

Zemsky, R., Wegner, G. R., & Massey, W. F. (2005). *Remaking the American university: Market-smart and mission-centered.* Piscataway, NJ: Rutgers University Press.

Zusman, A. (2005). *Challenges facing higher education in the twenty-first century*. Baltimore, MD: The Johns Hopkins University Press.

Appendix A

Incomplete List of Course/Curriculum Resources for iFoundry[5]

Faculty members in several departments have worked on courses and course materials that might be useful to the iFoundry mission to pilot new curriculum elements, arrangements, courses, modules, online resources, and other materials. The list given below is presented as an incomplete list of possible existing resources that can be useful to iFoundry. This list is not presented to suggest that all elements from all or any of these courses will be required in or even useful to iFoundry. It may be possible to recombine courses, extract modules, capture individual lectures, create useful course materials, and otherwise generate products to use for different departments in different ways as part of the iFoundry planning and implementation process.

Sample Resource Courses for iFoundry

ARNM 331 Image Studio
AVI 358 Human Factors
AVI 456 Human Performance and Engineering Psychology
ACCY 201, Accounting and Accountancy I
BADM 310, Management and Organizational Behavior
BADM 300, The Legal Environment of Business
BADM 320, Principles of Marketing
BADM 367, Management of Innovation and Technology
BADM 377, Project Management
CEE 417, Urban Transportation Planning
CEE 420, Construction Productivity
CEE 421, Construction Planning
CEE 422, Construction Cost Analysis
CS 210 Ethical and Professional Issues in Computer Science
CS 498 Social Computing
ECE 316 Engineering Ethics
GE 361 Interpersonal Skills and Emotional Intelligence
GE 400, Engineering Law
GE 401, Patent Law and Related Topic

[5] Goldberg, D. E. (2007). Whitepaper for an Illinois Foundry for Tech Vision and Leadership (iFoundry). Urbana-Champaign: University of Illinois.

GE 461, Introduction to Tech Entrepreneurship
GE 498AA, Decision Analysis I
GE498TEE The Entrepreneurial Engineer
GE 498MTV Creative Modeling for Tech Visionaries
GE 541 Managing Advanced Technology
GE Online Shortcourse Design of Innovation
HIST 364 Technology in Western Society (Lillian Hoddeson)
HIST 200F Engineering Change and Designing the Future
HIST 498 Science, Technology, and Gender
LIS 202, Social Aspects of Information Systems
NPRE 480, Topics in Energy Security
SOC 350, Technology and Society
SPCM 199 Communication Technology & Society
SPCM 496 Play and Technology
SPCM 496 Internet Law and Policy

Appendix B

The Illinois Engineering Freshman Experience[6]

The Illinois Engineering Freshman Experience or iEFX (previously called the iFoundry experience) is a special program that helps make the first year of Engineering at Illinois particularly rewarding and engaging. iEFX (pronounced I-Effects) is dedicated to enriching the freshmen experience through a unique orientation course in critical and creative thinking skills (ENG 100++ or the Missing Basics), hands-on projects and a student-run learning community, known as the iCommunity. Launched as an iFoundry pilot program in 2009, this combination of the Missing Basics Course, hands-on projects, and iCommunity powerfully affected student life and learning. Classroom and team experiences combine in ways that honor student aspirations and support student choice, leading to a celebration of the joys of engineering, learning, and community from the students' first steps into Engineering at Illinois.

The iEFX initiative and the iFoundry curriculum incubator are credited as forging an important breakthrough in engineering education. Data collected in Fall 2009 shows that iEFX is a transformative experience, which helps students build a strong sense of engineering identity, adjust to the social challenges of the first year of college, and build early networking experiences with other students, faculty, corporate and alumni advisors. Students in the inaugural pilot of iEFX built a vibrant engineering community and developed creativity, confidence, and initiative not usually seen in students who go through more traditional freshmen experiences. All admitted students to Engineering at Illinois departments, plus Agricultural and Biological Engineering in

[6] Adapted from the iEFX website at http://iefx.engineering.illinois.edu/

the College of ACES and Chemical and Biomolecular Engineering in the College of Liberal Arts & Sciences, are eligible to apply.

Engineering 100++

The iEFX program rests on some distinctive principles that inform and shape the ENG 100++ course, Introduction to the Missing Basics. ENG 100++ is a one-credit hour orientation course for all iEFX freshmen in Engineering. The basic philosophy of iEFX is that engineers need to have backgrounds and training that is mathematically and scientifically rigorous, but also attentive and diligent to qualitative thinking skills. The goal of iEFX is to support students' engineering aspirations in ways that establish a great beginning to an Illinois engineering education. Activities in iEFX are aimed at unleashing the inner builder in freshmen students, increase confidence, develop engineering skills, and cultivate teamwork. These principles come to life in ENG 100++: An Introduction to the Missing Basics. The course consists of two one-hour per week sessions; one hour is devoted to developing the qualitative thinking skills essential to becoming a great engineer, and one hour focuses on special hands-on projects.

iCommunity

The iCommunity is the student-led learning community at the heart of the iEFX experience. The iCommunity consists of small teams (iTeams) composed of vibrant mixes of students from all engineering departments. iTeams are built around student aspirations and engineering interests. In the iFoundry inaugural year, those aspirations centered on entrepreneurship and innovation, engineering as a discipline that addresses global and national challenges; and building innovative products and services. iTeams included: Entrepreneurship & Innovation, Engineering in Service to Society, Service and Systems Engineering, and Art &

Engineering Design. Additional iTeam topics will emerge as new students with different aspirations enter iEFX.

A Network of Support, Identity, and World of Work Connections

Each iTeam is paired with a dedicated network of faculty consultants, corporate advisors, and upper-level student mentors who work closely with the team on small projects, field trips, workshops, and social activities around their special engineering interests. As a result, students in iEFX find their iCommunity a rich locus which strengthens their identity as engineers, connects them to fellow students and friends, fosters early exposure to the world of work, and creates an academic support network.